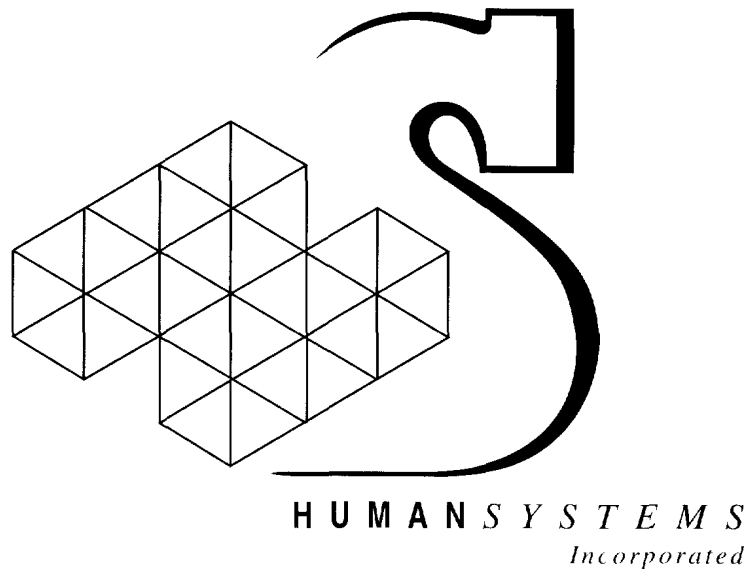


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**Additional Human Factors Evaluation
of the Proposed Generation III
Prototype Fragmentation Vests**

**PWGSC Contract No. W7711-7-7429/01-SRV
Order No. 7429-04**

March 2000

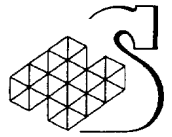
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Additional Human Factors Evaluation of the Proposed Generation III Prototype Fragmentation Vests

By

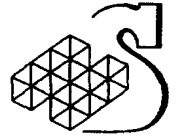
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PWGSC Contract No. W7711-7-7429/04-SRV
on behalf of
DEPARTMENT OF NATIONAL DEFENCE

as represented by
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31 March 2000



Executive Summary

In 1991, the Canadian Forces (CF) designed and built a fragmentation vest for the protection of our Land Force personnel against ballistic threats during military operations. Operational deficiencies with the fragmentation vest were reported shortly after introduction into service; these deficiencies included: excessive stiffness, degraded mobility, and incompatibility with helmets, weapon sights and in-service personal load carriage equipment. In order to resolve the in-service vest deficiencies, a series of human factors (HF) investigations were undertaken as part of the G2122 Fragmentation Vest Modification programme. Based on the recommendations from these trials, NDHQ selected a side-opening vest design as most suitable to pursue for the CF Fragmentation Vest Modification Programme (Generation II design). The aim of this programme was to salvage the ballistic fill of the deficient fragmentation vests and incorporate it into a better design.

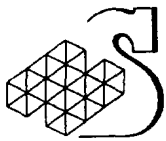
The G2122 programme was subsequently cancelled and a decision was made to not salvage the soft armour from existing in-service stocks, but rather to transfer funds and authority to procure a new fragmentation vest as part of the Clothe the Soldier (CTS) Project. The CTS project staff decided to develop two fragmentation vest prototypes incorporating the advantages afforded by new ballistic materials. One design was based upon the latest modification of the earlier Generation II design, and the other upon the "Danish" fragmentation vest design.

The primary aim of this field trial is to evaluate the human factors (HF) suitability of two new prototype fragmentation vest designs, by comparison with the original Generation II design.

A five-day field trial was undertaken at CFB Petawawa over the period 28 September to 02 October 1998. Three fragmentation vest systems were evaluated by a total of 24 regular force male (n= 16) and female (n=8) participants. A balanced repeated measures comparison between vest conditions was performed. The human factors tests included assessments of fit and adjustability; accessibility; coverage; range of motion; weapon, clothing and equipment compatibility; weapon firing; performance of selected obstacle and combat tasks; battle tasks; comfort; and user acceptance. Data collection included questionnaires, focus groups, performance measures and human factors observer assessments.

The modified Generation II vest (Vest A) was generally rated higher than the Danish version (Vest B) or the original Generation II vest (Vest C) across all evaluation metrics. Vest A was rated the most acceptable vest in the compatibility stands, combat task stands, firing stands, battle task stands and in the exit questionnaire. Vest B was generally rated the least acceptable vest across all evaluation metrics. Vest B was also rated as being unacceptable in many areas. While 74% of the subjects believed that Vest A was the best vest evaluated, 26% of the participants viewed Vest C as the best vest evaluated. None of the participants believed Vest B was acceptable for service issue. Minor modifications to Vest A would make it acceptable by 100% of the participants.

Based on the results of this controlled HF Field trial, Vest A with modifications was recommended for future Canadian Forces (CF) procurement. Modifications and suggestions for further work are provided.



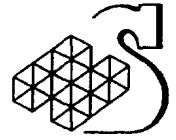
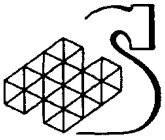
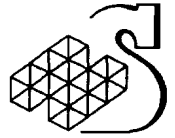


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1. Introduction

References:

- A. Project G2122 Fragmentation Vest Modernization Programme.
- B. Human Factors Review of Possible Approaches to the G2122 Fragmentation Vest Modernization Programme (Phase 1) - Humansystems Report Contract No. W7711-2-7151/04, dated 3 December 1993.
- C. Human Factors Evaluation of Possible Approaches to the G2122 Fragmentation Vest Modernization Programme (Phase 2) - Humansystems Report Contract No. W7711-2-7151/04, dated 31 March 1994.
- D. Human Factors Review of Nine Fragmentation Vest Prototypes - Humansystems Report Contract No. W7701-3-7109-05/XSE, dated 18 September 1994.
- E. Human Factors Assessment of Prototype Fragmentation Vests - Humansystems Report Contract No. W7701-3-7197-05/XSE, dated 10 August 1995.
- F. Statement of Work: Additional Human Factors Evaluation of the Proposed Generation III Canadian Forces Fragmentation Vest.

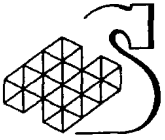
1.1 Background

In 1991, the Canadian Forces (CF) designed and built a fragmentation vest (Generation 0 or Gen 0) for the protection of our Land Force personnel against ballistic threats during military operations. Operational deficiencies with the fragmentation vest were reported shortly after introduction into service; these deficiencies included: excessive stiffness, degraded mobility, and incompatibility with helmets, weapon sights and in-service personal load carriage equipment.

In order to resolve the excessive stiffness problem with the Gen 0, the one-piece back panels were split horizontally and attached with elastic straps. While this modification (Generation 1 or Gen 1) was an improvement, many soldiers still did not feel capable of performing all their duties. In order to correct the vests operational deficiencies, a series of human factors (HF) investigations were undertaken (References B, C, D, E). The aim was to determine the scope of changes that could be accomplished in the Gen 0 and Gen 1, establish requirements for an optimal fragmentation vest design, and to define suitable designs and modifications to correct the limitations in the Gen 0 and Gen 1.

Three Canadian body armour manufacturers were approached to produce prototype fragmentation vests in the following configurations: side opening, front opening, and concealable. All vest designs included the capability for incorporating hard armour ceramic plates onto the front and back of the torso. A human factors expert paper-based evaluation of these prototypes was conducted in August 1994 (Reference D). Based on this analysis, the CF down-selected to two vest designs for further feature refinement and subsequent Human Factors (HF) field trial evaluation of the two designs (Reference E).

A detailed one-week HF field trial was undertaken in May 1995 to evaluate the two fragmentation vest designs under scientifically controlled testing conditions. This HF trial included assessments of fit and adjustability, performance effectiveness in combat and battle task activities, thermal and physical demands, accessibility, maintainability, User acceptance, and clothing/equipment/vehicle compatibility, based on the HF criteria developed at Reference C. An additional one-month field



evaluation was undertaken by Trials and Evaluations (T&E) Gagetown in April 1995 to evaluate the two fragmentation vest designs under appropriate battlefield conditions. The T&E trial involved approximately 100 soldiers operating as part of a combat team in all phases of war. Based on the recommendations from these trials, NDHQ selected a side-opening vest design as most suitable to pursue for the CF Fragmentation Vest Modification Programme.

Due to limitations with the earlier human factors and T&E trials, additional testing was conducted to evaluate the effects of adding hard armour. Based on the results of these trials, modifications to the vest were recommended and a modification data package for the G2122 Programme was developed.

The G2122 programme was subsequently cancelled and a decision was made to not salvage the soft armour from existing in-service stocks, but rather to transfer funds and authority to procure a new fragmentation vest as part of the Clothe the Soldier (CTS) Project. The CTS project staff decided to develop two fragmentation vest prototypes incorporating the advantages afforded by new ballistic materials. One design was based upon the latest modification of the earlier Generation II design, and the other upon the "Danish" fragmentation vest design

2. Aim

The primary aim of this field trial was to evaluate the human factors (HF) suitability of two prototype fragmentation vest designs, by comparison with the original Generation II (Gen II 96A) design.

3. Method

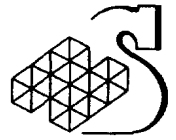
3.1 Overview

The following description provides a general overview of the trial method. Further details are provided in subsequent sections.

A one-week field trial was undertaken at CFB Petawawa over the period of 28 September to 2 October 1998. Twenty-four regular force personnel were required to undertake a battery of human factors tests while wearing six different fragmentation vest/fighting order conditions in a partially repeated measures design. During each test, the order of conditions was balanced amongst participants. Human factors tests included assessments of fit, adjustability, accessibility, range of motion, performance of select obstacle and battle tasks, range firing, equipment, vehicle and clothing compatibility clash, grenade throwing, and maintainability. Data collection included questionnaires, focus groups, performance measures and HF observer assessments.

3.2 Trial Conditions

The field trial included three fragmentation vest conditions: Gen II (Vest C), modified Gen II or Gen III (Vest A) and the Danish vest (Vest B), two Fighting Order conditions: Tactical Assault Vest (TAV) and the in-service 82 pattern webbing, and two hard armour conditions (with and without armour plates). With a total of twelve possible conditions and only six days of testing available, these conditions were rationalized to minimize testing time without compromising testing quality and validity. A full repeated



measures protocol across all twelve conditions was likely unachievable, given the number of human factors tests in the five days available. For this reason, priority was given to the fragmentation vest and fighting order conditions; the hard armour conditions were only tested selectively in the trial protocol. These condition considerations are discussed in more detail below.

3.2.1 Fragmentation Vest Conditions

The male participants were split into two matched independent load carriage groups by random assignment. One group was assigned to assess the fragmentation vests with in-service webbing, while the second group was assigned to assess the fragmentation vests with the prototype tactical assault vests (TAV). Each group of males evaluated all the fragmentation vest designs in a repeated measures protocol. The female trial participants evaluated the fragmentation vests with the prototype TAVs in a repeated measures protocol. The trial conditions were as follows:

		Fragmentation Vest Conditions		
		Vest A	Vest B	Vest C
Fighting Order Conditions	82 Pattern Webbing N= 8 ♂	Gen III Vest with Webbing N= 8 ♂	Danish Vest with Webbing N= 8 ♂	Gen II Vest with Webbing N= 8 ♂
	TAV N= 8 ♂ N= 8 ♀	Gen III Vest with TAV N= 8 ♂ N= 8 ♀	Danish Vest with TAV N= 8 ♂ N= 8 ♀	Gen II Vest with TAV N= 8 ♂ N= 8 ♀

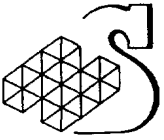
Table 1: Composite Vest Conditions

Using a Power analysis ($p < 0.05$) of the previous fragmentation vest trial (Reference E), a minimum of eight participants were required for the repeated measures tests. Given the numbers of subjects available and the lack of subject dropout, significant differences between designs were recorded.

Nested within the fragmentation vest designs was a shell material denier factor. One-half of the fragmentation vests (8) of Vest A and Vest C were constructed with 500 denier while the remaining half (8) were constructed with 1000-denier material. Shell material types were coded by vest number and thus invisible to the participants. Differences in material durability, vest stiffness and comfort were determined during post-hoc analysis of the C7 Rifle Firing and the Fire and Movement FIBUA results.

3.2.2 Fighting Order Conditions

The two fighting order conditions were standardized for load item configuration. This standardization ensured the bulk and weight implications of each individual load order were comparable, both between and within fighting order conditions, and equivalent across all participants. The standard “field trial” load order is detailed below in Table 2.

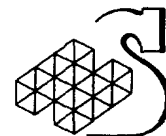


Load Order Item	Number
C7 Magazine (with 30 rds)	5 (one on the rifle)
1 Qt. Canteen (filled)	1
M67 HE Grenade	1
HC1A1 Smoke Grenade	1
Bayonet	1
Multi-tool	1
Pen Light	1
Insect Repellent	1
Sunscreen	1
Gloves Temperate	1 pr
Flare Projector	1
Field Dressings	2
C9 Drum (200 rds) (for C9 gunner only)	1

Table 2: Fighting Order Load

3.2.3 Hard Armour Plate Conditions

Hard armour plates will increasingly become an integral up-armour capability of any future fragmentation vest in order to provide the soldier with additional protection against large fragments and direct fire threats. While this field trial was not convened to assess hard armour plates directly, the interaction between the in-service hard armour plates and the three fragmentation vest designs was evaluated. Therefore, the hard armour conditions were carefully allocated to various tests to represent the likely conditions of intended use and to emphasize plate interactions. These allocations are summarized in Table 3 below.



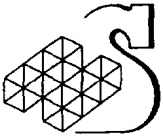
Human Factors Evaluation	Without Plates	With Plates
Range of Motion	✓	✓
Protective Coverage	✓	✓
Accessibility	✓	✓
First Aid Removal	✓	
Compatibility Dry Stands	✓	✓ (select stands)
Obstacles	✓	
Small Arms Range	✓	✓
Fire & Movement	✓	✓
FIBUA	✓	
Grenade Range	✓	
Vehicle Compatibility	✓	✓ (hatches up)
Civilian Vehicle Inspection	✓	

Table 3: Hard Armour Test Allocation

Select compatibility tests (C7A1 and C9A1) were undertaken to evaluate the plate implications on various weapons firing postures. Fire and movement tasks were performed with hard armour to assess the implications on speed and ease of movement, tactical implications for use of ground and firing postures, and comfort effects. The suitability of hard armour with each vest design was also assessed for vehicle compatibility.

3.3 Participants

Twenty-four regular forces soldiers (including 16 males and 8 females) were selected from a range of specific torso sizes from pre-selected participants. Due to limited numbers of female participants, female soldiers were not selected to represent the range of possible breast cup sizes. The participants selected for this trial were organized into three Sections (e.g. Sections A, B, and C), each with 8 soldiers. Each Section was balanced for chest, gender, and MOC, so that each Section was as similar as possible (i.e. matched groups). An HF observer was assigned to work with each Section for the purposes of data collection and focus group discussions.



3.3.1 Chest Size

Each prototype fragmentation vest design was produced for this trial in three chest sizes (i.e. small, medium and large) according to Table 4 below. The size tariffing in Table 4 is based on male chest circumference dimensions from the 1997 Land Force Anthropometry Survey.

	Garment Size		
	Small	Medium	Large
Tariff % (n)	22% (3)	57% (9)	21% (3)
Chest Circ.	84 - 96 cm	96 - 109 cm	109 – 122+ cm

Table 4: Garment Sizing and Trial Tariffing

For reasons of economy, the vests were made in three chest sizes and just one torso (length) size - regular. It is envisaged that the production vest will be made in three torso lengths - short, regular and tall and up to four chest sizes.

To facilitate efficient use of the prototype fragmentation vests throughout the trial, participants with similar torso sizes were paired together in each Section. The order of fragmentation vest testing was balanced both within each Section and between paired participants to ensure there were no unnecessary delays.

3.4 Fragmentation Vests

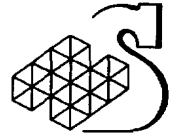
Three fragmentation vest conditions were evaluated. The vests included Generation III vest (Vest A), the Danish vest (Vest B), and the Generation II vest (Vest C). A no-fragmentation vest baseline condition (i.e. load carriage only) was included for range of motion, obstacle course tasks, range firing tasks and battle tasks. Vest drawings with highlighted features are included at Annex A.

3.5 Load Carriage Systems

Two load carriage conditions were evaluated. The load carriage systems included the in-service 82–Pattern Webbing and the prototype CTS tactical assault vest (TAV). Drawings of the load carriage conditions are included at Annex A.

3.6 Weather conditions

The fragmentation vests were evaluated during seasonal autumn conditions at CFB Petawawa (28 September to 03 October 1998). Temperatures ranged between 3.5 and 19.6°C. It drizzled lightly on days 1, 2 and 3 and rained intermittently on day 4 – see Table 5.



Date	Daytime High	Daily Low	Precipitation
28 September	17.0°C	9.0°C	Trace
29 September	19.0°C	2.0°C	1.0 mm
30 September	16.5°C	10.5°C	6.2 mm
01 October	10.5°C	5.5°C	Trace
02 October	11.5°C	1.5°C	none

Table 5: Trial Weather Conditions

3.7 Data Collection

Data collection focussed on the following HF criteria. Test content is described in more detail below. The order of fragmentation vest conditions was balanced.

- | | |
|----------------------------------|-----------------------------|
| 1. Anthropometry | 9. C7 and C9 Range Firing |
| 2. Fit/Adjustability | 10. Grenade Throwing |
| 3. Protective Coverage | 11. Vehicle Inspection |
| 4. Armour Fill Accessibility | 12. Battle Task Performance |
| 5. Casualty Evacuation | 13. Thermal Load |
| 6. Range of Motion | 14. Physical Comfort |
| 7. Clothing/Equip. Compatibility | 15. User Acceptance |
| 8. Vehicle Compatibility | 16. Features |

3.7.1 Anthropometry:

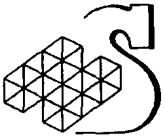
Each participant was measured for stature, weight, chest and waist (omphalion) circumference, shoulder length, acromial height, suprasternale height and iliocristale height. Torso length was derived from the difference between the acromial and iliocristale heights. Female participants were additionally measured for chest circumference below the breast.

3.7.2 Fit/Adjustability:

Participants were required to adjust vest sizing and perform donning/doffing trials. Once each vest was fitted and adjusted, the height of the vest hem was measured in relation to the iliocristale height. Upon completion of adjustment and fitting, participants completed a Fitting Questionnaire. HF observers evaluated the ease of fitting and the acceptability of the final fit.

3.7.3 Protective Coverage:

With the vest adjusted and fitted to the participants, the limits of soft and hard armour coverage were measured. Firstly, the limits of soft armour coverage were determined by measuring the height of the



soft armour hem relative to the iliocristale height, the height of the front of the neck opening relative to the sternal notch, and length of shoulder coverage from the acromium. Hard armour coverage was then determined by measuring the top of both the front and back hard armour plates in relation to the sternal notch.

3.7.4 Armour Accessibility:

Participants were required to remove and re-insert both the hard and soft armour components in each fragmentation vest design. Participants rated the ease and reliability of armour removal and insertion. HF observers evaluated the ease of accessibility and determine the likelihood and impact of installation errors.

3.7.5 Range of Motion:

Each participant donned and adjusted each fragmentation vest condition over their combat clothing. The following ranges of motion were then measured for both fragmentation vest designs worn without fighting order. All measures also included a combat clothing baseline.

Shoulder Abduction: Standing with their backs to a wall, participants raised their straight right arm laterally in the frontal plane until they perceived resistance. The HF observer then measured the angle of the upper arm, relative to the vertical, at the point of resistance.

Medial Shoulder Flexion: Standing, bent forward at the waist with the back parallel to the floor, participants moved their straight right arm medially across their chest until they perceived resistance. The HF observer then measured the angle of the upper arm, relative to the vertical, at the point of resistance.

Sagittal Waist Flexion: Sitting on the floor with straight legs and their feet about 30 cm apart, participants bent forward at the waist while reaching forward along a measuring stick. The HF observer measured the sustained reach distance.

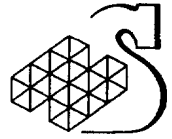
Sagittal Neck Extension: Standing upright with straight legs and their feet about 30 cm apart, participants extended their head and neck back until they perceived resistance. All participants wore their new Soldier's helmet for this test. The HF observer measured the final neck extension angle and noted any helmet/fragmentation vest clash.

3.7.6 Clothing/Equipment Compatibility:

Fragmentation vest/fighting order compatibility clash was identified and evaluated indoors at four static test stands. Participants were divided into smaller groups to perform the required drills and the HF observers collected compatibility measurement data and participant ratings. Participants were encouraged to adjust and configure their fragmentation vest and fighting order to the best of their ability to accommodate the test clothing and equipment prior to each test. Each participant was evaluated collectively under the close observation of the HF observer. The static test stands were comprised as follows:

- **Clothing:** IECS Jacket, IECS Parka, and Combat Gloves.
- **Weapons:** C7A1 rifle, C9A1 LMG, M72 SRAAW, Carl Gustav.

Participants were required to rate the compatibility of each fragmentation vest/fighting order and select plate conditions with each of the selected weapons, equipment, and clothing combinations at each test



stand. HF observers measured clothing and equipment stand-off and noted instances of compatibility clash and the accommodation required to perform each drill.

3.7.7 Vehicle Compatibility

All fragmentation vest/fighting order and select hard armour conditions were evaluated for compatibility with two infantry vehicles: MLVW and Bison. Order of conditions was balanced. Specific evaluations included:

- **Access/Egress:** Participants were required to rate the ease of access and egress of vehicle hatches and doors. HFE observers evaluated soldiers entering and exiting vehicles for any postural, range of movement, and vehicle obstruction effects.

3.7.8 Combat Activity Performance

Fragmentation vest effects on the performance of military combat and peacekeeping tasks were evaluated for selected activities (obstacle course, grenade throw, range firing, and civilian vehicle inspection).

3.7.8.1 Obstacle Course:

The following obstacles were undertaken consecutively as part of a single course. Subjective ratings by trial participants and performance timings were collected for each test. Participants performed these tests in their assigned fragmentation vest/fighting order conditions. At the completion of the obstacle course for each condition, participants were required to complete a Task Questionnaire. For each obstacle, participants wore the New Soldier's Helmet and carried their personal weapon. The following obstacles were used:

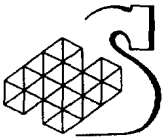
- **100m Dash:** Sprint 100m.
- **Ladder Obstacle:** Ascend a 10m ladder, straddle and traverse the top bar, then descend the ladder to the ground.
- **Crawl:** Perform a Leopard crawl while traversing a 10m low wire obstacle.
- **Wall Obstacle:** Run 3m and climb (assisted) over a 2.4m high wall.
- **Pit Obstacle:** Run up a 2m ramp and jump down into a sandpit and perform a forward roll.
- **Over and Under Obstacle:** Climb over and under five successive poles mounted 0.5 and 1.0 meter from the ground.
- **Mouse Hole Obstacle:** Crawl through a square, concrete mouse hole shaft for 1m and climb over and under three successive poles mounted 0.5m, 1.0m, and 0.5m above the ground.

3.7.8.2 Grenade Throw:

Participants threw a dummy grenade in each fragmentation vest/load carriage condition assigned into a target circle (6-meter diameter) from a prone position at a distance of 15 meters. Participants indicated a performance rating score for each condition and HF observers recorded whether the grenade landed in the target circle.

3.7.8.3 Civilian Vehicle Inspection:

This drill was designed to simulate the civilian vehicle inspection procedures required during peacekeeping roadblock checkpoints. Inspection activities included a standing inspection of the exterior bodywork, a kneeling inspection of a wheel well, a prone inspection of the car underside



below the trunk, and stooped/crouched inspection of the passenger seat area. Participants indicated a performance rating score for each vest condition.

3.7.8.4 Casualty Removal:

Working in pairs, participants were required to simulate vest removal from a prone, injured soldier. Participants rated the ease of removal, both as the first aid provider and as the injured participant. HF observers evaluated the ease of vest removal and the extent of injured soldier movement/handling required.

3.7.9 Range Firing:

Using a small arms range, participants performed the following modified personal weapons test serials with the C7A1 rifle.

- Serial 1:** Grouping and zeroing at 100m (prone).
- Serial 2:** Fire and Movement starting in the prone position at 400m.
 - a) Double to 300m (prone unsupported, two Figure 11s).
 - b) Double to 200m (kneeling supported, two Figure 11s).
 - c) Double to 100m (prone unsupported, two Figure 12s)
 - d) Walk to 50m (standing, snapshooting, one Figure 11).

All participants performed a familiarization shoot with the C9A1 LMG. Each participant undertook range firing in each fragmentation vest/fighting order condition. Additionally, infantry subjects performed the run-downs while wearing hard armour plates. Participant performance was evaluated using target range scoring. Participants were also required to rate the performance, convenience, and comfort of each condition. HF observers also evaluated compatibility issues associated with firing. At the completion of range firing, participants were required to complete a Task Questionnaire for each condition.

3.7.10 Battle Task Performance

Several combat activities were combined to perform different battle tasks. Fragmentation vest/fighting order and hard armour effects on soldier performance were evaluated for two battle tasks: Fire and Movement, and Fighting in Built up Areas (FIBUA) house clearing. Participant performance ratings and HF observer assessments were collected following each task.

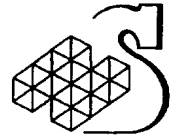
3.7.10.1 Fire and Movement:

Participants were required to engage in a Section attack simulation. Participants rated their task/battle effectiveness in all conditions. HF observers evaluated the speed, agility, and postural effects of each condition.

Three Sections performed the fire and movement testing at one time. Members of the supporting staff simulated enemy positions in a defensive position and the trial participants performed standard skirmishing fire and movement to advance and assault the enemy position. All sections were issued blank ammunition, smoke and pyrotechnics. At the completion of each attack, participants were required to complete a Task Questionnaire. The order of conditions was balanced within each Section. At the completion of the fire and movement task, the Sections conducted the FIBUA assault.

3.7.10.2 FIBUA House Clearing:

Infantry participants were required to engage in a house clearing simulation. Participants rated their task/battle effectiveness in all conditions. HF observers evaluated the speed, agility, accessibility and postural effects of each vest and load carriage condition.



Three Sections performed the house clearing drill at one time. Members of the supporting staff simulated enemy positions within the FIBUA complex as the participants performed the house clearing task. All sections were issued blank ammunition, smoke and pyrotechnics. After break-in the sections cleared the FIBUA complex, room to room, one floor at a time. Maximum use of ceiling and wall mouse holes was required. At the completion of each condition participants were required to complete a Task Questionnaire. The order of conditions was balanced within each Section.

3.7.11 Thermal Load:

The thermal demands associated with each prototype fragmentation vest/fighting order condition were evaluated during the section attacks and FIBUA assaults. Following each section attack/FIBUA assault, participants were required to complete a thermal comfort questionnaire. This questionnaire was comprised of drawings of the front and back profiles of the torso. Participants were required to indicate the location of any heat build-up and rate the amount of thermal discomfort using the five point rating scale provided.

3.7.12 Physical Discomfort:

Following each section attack/FIBUA assault, participants were required to complete a physical comfort questionnaire. This questionnaire was comprised of drawings of the front and back profiles of the torso. Participants were required to indicate the body location and rate the extent of discomfort using the five point rating scale provided. Discomfort could include, but was not limited to, contact irritation or pressure points. Human factors staff investigated any reports of discomfort through interviews with affected participants.

3.7.13 User Maintainability/Durability:

The ease and effectiveness with which a participant can effect minor repairs and cleaning in the field was evaluated through maintenance simulations, focus group discussion, and questionnaire ratings. HF observers observed any routine maintenance tasks as they occurred in the field. All repairs were logged and reviewed for durability issues. Suitability for field cleaning was evaluated in the field as appropriate. All prototype fragmentation vests were inspected by the CTS staff for wear and damage at the completion of the trial.

3.7.14 Features

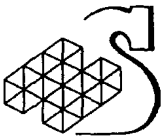
At the completion of the trial, participants were required to rate the suitability of select, prototype fragmentation vest design features: buckles, adjustments, coverage, collars, shoulder flaps, etc. These features were discussed in detail during the exit focus group to identify feature concerns and suggestions for improvement.

3.7.15 User Acceptance:

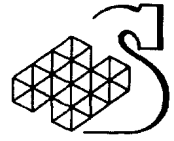
To assess user acceptance, participants were required to rate their overall acceptance of each vest, including their perceived level of protection, wearability, and the general appearance of the garment, using the exit questionnaire.

3.8 Trial Schedule

Table 5 outlines the five-day trial schedule. Where necessary, trial evaluations extended into the evenings.



TRIAL WEEK: 28 Sep. – 02 Oct. 1998					
Time	Monday	Tuesday	Wednesday	Thursday	Friday
0745-0830	Initial Briefing	Compatibility (Test Stands)	Small Arms Range	Small Arms Range C9	Fire & Move't FIBUA Assault
0830-1015	Anthropometry Issue FVs and LC	Compatibility (Test Stands)	Small Arms Range	Small Arms Range C9	Fire & Move't FIBUA Assault
1030-1230	Fitting/Adjust. & Protective Coverage	Compatibility (Test Stands)	Small Arms Range	Small Arms Range C9	Fire & Move't FIBUA Assault
Lunch					
1300-1400	Fitting/Adjust. & Protective Coverage (cont) Accessibility	Compatibility (Test Stands) Vehicle Compat	Small Arms Range	Obstacle Course Grenade Throw	Fire & Move't FIBUA Assault
1430-1730	Range of Motion/ First Aid Removal Issue Load Order Items	Compatibility (Test Stands) Vehicle Compat	Small Arms Range	Grenade Throw (cont) Vehicle Inspection	Feature Quest. Exit Quest. Exit Focus Group
Supper					
	Fitting/Adjust. & Protective Coverage (cont)	Obstacle Course	Small Arms Range	Spare	Vest Inspection for Damage



4. Results

Trial results are detailed in the following Annexes and summarized below.

Participant Characteristics:	Annex B
Fit and Adjustability:	Annex C
Coverage:	Annex D
Accessibility:	Annex E
Range of Motion:	Annex F
Compatibility:	Annex G
Combat Activities:	Annex H
Range Firing:	Annex I
Battle Tasks:	Annex J
Comfort:	Annex K
Exit Focus Group:	Annex L

4.1 General

4.1.1 Gender Effects

A post-hoc analysis of the Exit (Without Plate) Questionnaire did not identify any significant overall gender effect for vest acceptability. While there was no overall gender effect, females did rate some fragmentation exit questions significantly differently ($p < 0.05$) than the male subjects for certain vest types. Results for each vest and plate condition are described below.

Females rated the Compatibility with Weapons for Vests A and B significantly ($p < 0.05$) less acceptable than the male participants- *Barely Unacceptable* for Vest A versus *Barely Acceptable* and *Reasonably Unacceptable* for Vest B versus *Borderline*. Females rated the ease of movement with Vest C as being significantly ($p < 0.05$) less acceptable than the males - *Barely Unacceptable* versus *Borderline to Barely Acceptable*. Females rated the acceptability of the thermal comfort associated with Vest B as being significantly ($p < 0.05$) more acceptable than their male counterparts – *Borderline* versus *Barely Unacceptable*. Finally, the female participants rated the physical comfort associated with Vests A and C as being significantly ($p < 0.05$) less acceptable than the male participants – *Borderline to Barely Unacceptable* versus *Borderline to Barely Acceptable*. The results for the Exit questionnaire (Without Plates) are displayed below in Figure 1.

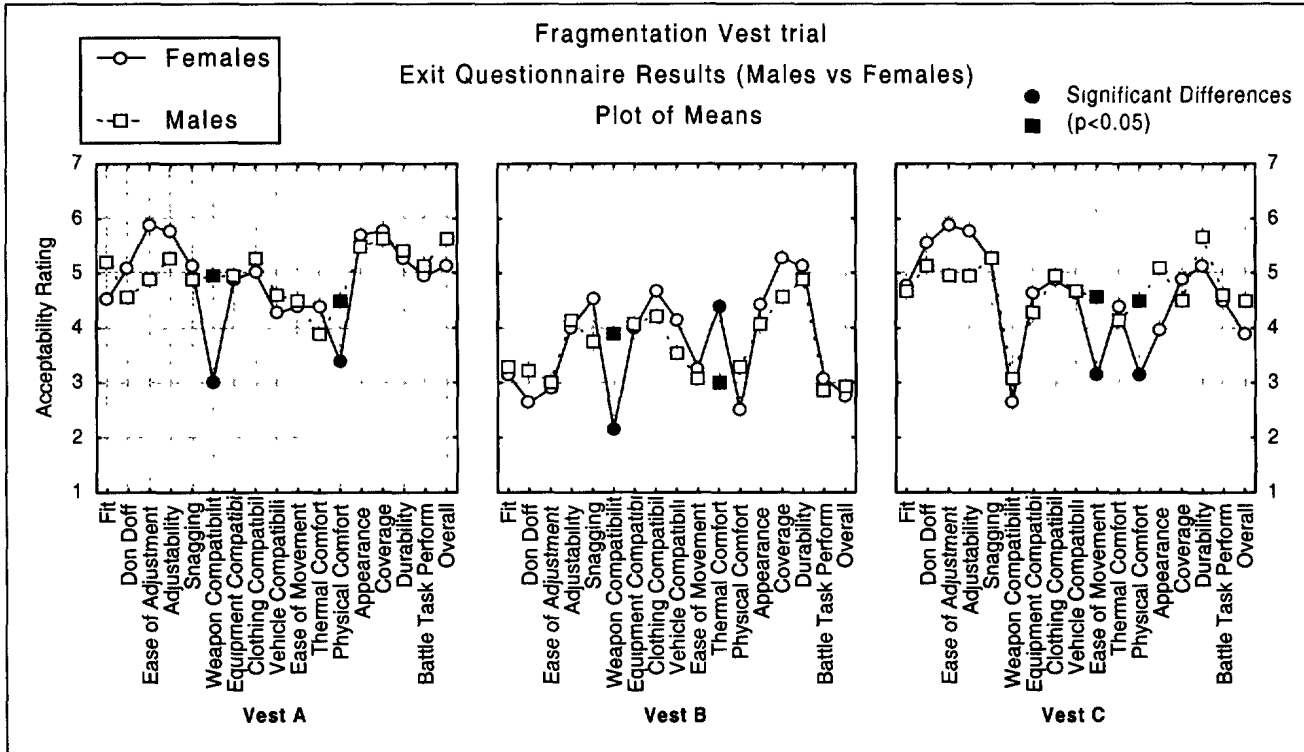
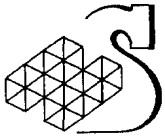


Figure 1: Exit Questionnaire Results (Males vs. Females)

As will be discussed in the Section 4.2 and in Annex B, except for cup size, the female subjects were generally representative of females in the Land Force (anthropometrically). Thus, extreme caution should be used before inferring any results to the general Land Force female population.

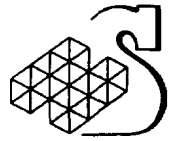
4.1.2 Shell Material Effects

A post-hoc analysis of the C7 Rifle Firing and the Fire and Movement/FIBUA Task Questionnaires did not identify any significant shell material effect. While the participants indicated that the durability of the vests with the higher denier fabrics was more acceptable, the results were not significant. Similarly, while the subjects indicated that the vests with the higher denier shell materials were more acceptable for chaffing, they were not significantly better than the 500 denier shelled vests.

There was no notable difference for vest stiffness within shell material types.

4.1.3 Load Carriage Effects

Due to the loss of one subject because of a foot injury, only seven male subjects completed the trial while wearing the 82-Pattern webbing. Conversely, all the females and eight additional males completed the trial while wearing the TAV. Half of the male subjects wearing the 82-Pattern webbing were infantrymen.



4.1.3.1 Exit Questionnaire (Without Plates) - Load Carriage Effects

A post-hoc analysis of the Exit (Without Plate) Questionnaires identified a significant ($p < 0.05$) load carriage vest effect. While there was no overall load carriage effect for Vests A and C, participants wearing the 82 pattern webbing rated the acceptability of Vest B significantly ($p < 0.05$) less acceptable (*Barely Unacceptable*) than the participants wearing the TAV. Results for each vest and load carriage condition are described below and displayed in Figure 2.

Vest A: Overall, there was no significant ($p < 0.05$) difference between the Exit Questionnaire results between the wearers of the 82-Pattern webbing or the TAV for Vest A. There were however significant differences ($p < 0.05$) for two Exit Questions, Donning & Doffing and Ease of Adjustment. The 82-Pattern webbing users rated Donning & Doffing and Ease of Adjustment (*Borderline* versus *Barely to Reasonably Acceptable*) significantly ($p < 0.05$) less acceptable than the TAV wearers for Vest A.

Vest B: Overall, there was a significant ($p < 0.05$) difference between the Exit Questionnaire results between the wearers of the 82-Pattern webbing or the TAV for Vest B. There were significant ($p < 0.05$) differences for five Exit Questions: Adjustability, Snagging, Thermal Comfort, Coverage and Durability. The 82-Pattern webbing users rated Adjustability, Snagging, Thermal Comfort, Coverage and Durability (*Borderline to Reasonably Unacceptable*) significantly ($p < 0.05$) less acceptable than the TAV wearers for Vest B.

Vest C: Overall, there was no significant ($p < 0.05$) difference between the Exit Questionnaire results between the wearers of the 82-Pattern webbing or the TAV for Vest C. There were however significant ($p < 0.05$) differences for three Exit Questions, Weapon & Equipment Compatibility and Ease of Adjustment. The 82-Pattern webbing users rated Weapon Compatibility and Physical Comfort significantly ($p < 0.05$) more acceptable than the TAV wearers. Conversely, the 82-Pattern webbing users rated Equipment Compatibility (*Borderline* versus *Barely to Barely Unacceptable*) significantly ($p < 0.05$) less acceptable than the TAV wearers for Vest C.

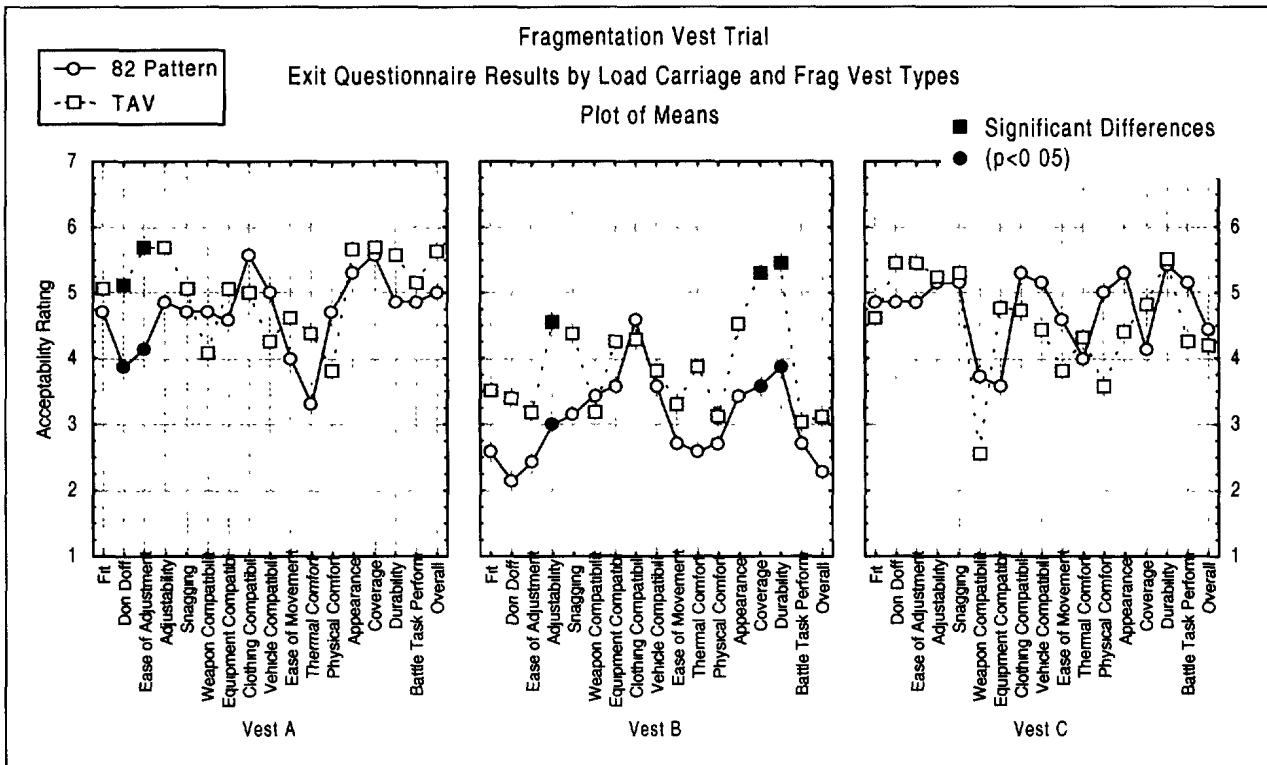
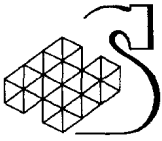


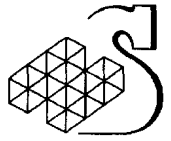
Figure 2: Exit Questionnaire Results (Load Carriage Effects)

4.1.3.2 Exit Questionnaire (With Plates) – Load Carriage Effects

A post-hoc analysis of the Exit (With Plates) Questionnaires identified a significant ($p < 0.05$) load carriage vest effect. While there was no overall load carriage effect for Vests A and C, participants wearing the 82 pattern webbing rated the acceptability of Vest B significantly ($p < 0.05$) less acceptable than the participants wearing the TAV (*Barely Unacceptable*). Results for each vest and load carriage condition are described below and displayed in Figure 3.

Vest A: Overall, there was no significant ($p < 0.05$) difference between the Exit Questionnaire results between the wearers of the 82-Pattern webbing or the TAV for Vest A. There were however significant ($p < 0.05$) differences for two Exit Questions, Donning & Doffing and Ease of Adjustment. The 82-Pattern webbing users rated Donning & Doffing and Ease of Adjustment (*Borderline* versus *Barely to Reasonably Acceptable*) significantly ($p < 0.05$) less acceptable than the TAV wearers for Vest A.

Vest B: Overall, there was a significant ($p < 0.05$) difference between the Exit Questionnaire results between the wearers of the 82-Pattern webbing or the TAV for Vest B. There were significant ($p < 0.05$) differences for four Exit Questions: Donning & Doffing, Adjustability, Coverage and Durability. The 82-Pattern webbing users rated Donning & Doffing, Adjustability, Coverage and Durability (*Borderline to Reasonably Unacceptable*) significantly ($p < 0.05$) less acceptable than the TAV wearers for Vest B.



Vest C: Overall, there was no significant ($p < 0.05$) difference between the Exit Questionnaire results between the wearers of the 82-Pattern webbing or the TAV for Vest C. There were however significant ($p < 0.05$) differences for two Exit Questions, Weapon Compatibility and Physical Comfort. The 82-Pattern webbing users rated Weapon Compatibility and Physical Comfort significantly ($p < 0.05$) more acceptable than the TAV wearers.

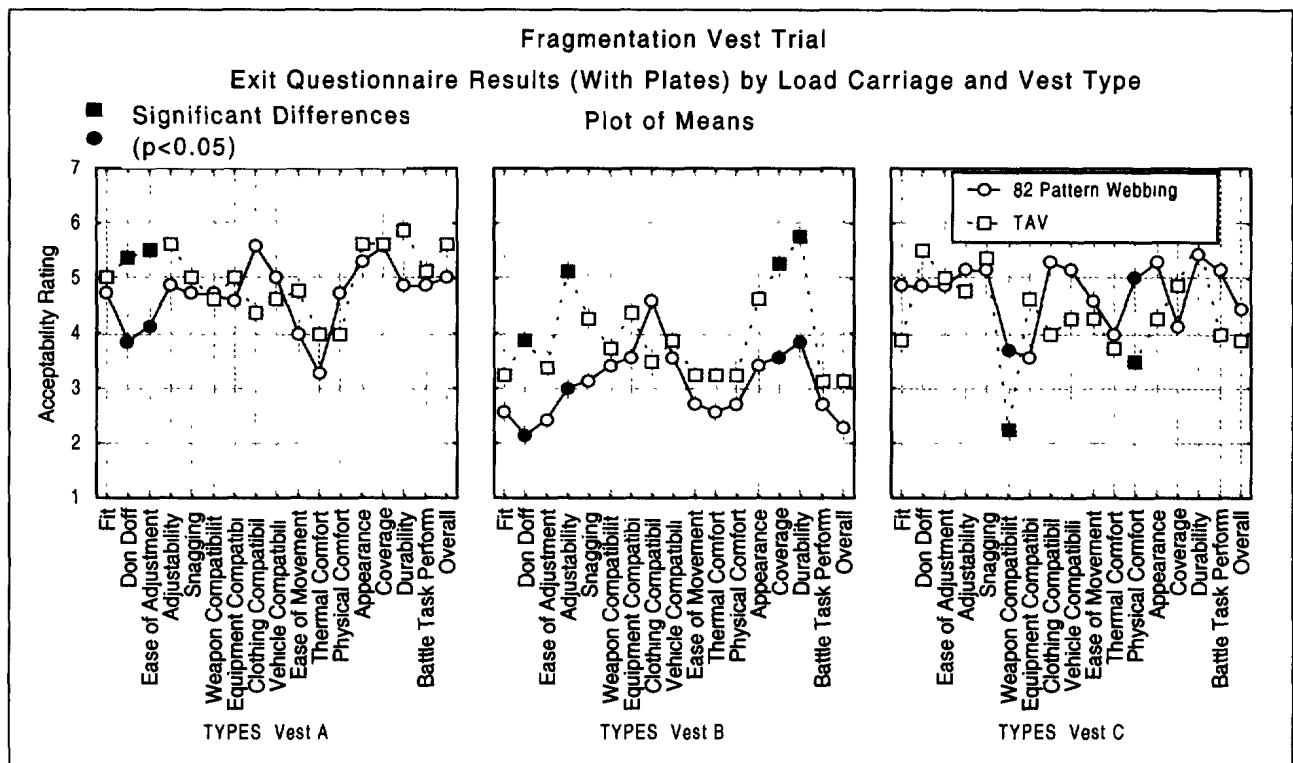


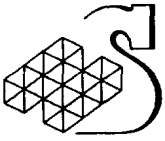
Figure 3: Exit Questionnaire Results (With Plates) - Load Carriage Effects

4.1.4 Gender and Load Carriage Interaction Effects

A post-hoc analysis of the Exit (Without Plate) and exit (With Plate) Questionnaires identified a significant ($p < 0.05$) interaction effect for the male subjects and load carriage type for Vest B. Males wearing the 82-Pattern webbing rated Vest B significantly lower than corresponding males wearing the TAV. The higher rating of the males wearing the TAVs may be due to the glow or shiny new kit effect of the new TAV (i.e. Hawthorne Effect) or it may be due to fact that Vest B was less compatible with 82-pattern webbing than the other vests. Females did not evaluate the 82-pattern webbing condition and thus could not evaluate the Load Carriage X Gender X Vest Type interaction.

4.2 Participant Characteristics (see Annex B)

The trial participants' anthropometric measurements were compared to the 1997 DCIEM Land Forces Anthropometric Survey (Reference F) to determine whether the trial participants were representative of the general Land Force.



These results suggest that while there was generally a good representative range of body lengths and circumferences amongst trial participants, females with small cup sizes were over represented.

4.3 Fit and Adjustment (see Annex C)

Participants were first selected based upon torso length sizing criteria (i.e., acromial height - iliocrystal height) and then preliminarily assigned vests according to chest circumference. Participants then performed all necessary fitting adjustments, and practised accessing vest soft and hard armour. If necessary and possible, subjects were assigned to a more acceptable fitting vest. Participants then completed an initial fit and adjustability questionnaire and were measured to determine vest coverage.

Overall, the participants achieved an acceptable fit with each of the three vest conditions. The participants did rate Vest A and C significantly ($p < 0.05$) more acceptable than Vest B for overall fit and adjustability.

4.4 Coverage (See Annex D)

With the vest adjusted and fitted to the participants, the limits of soft and hard armour coverage were measured. The torso (front) and neck coverage provided by Vest B was significantly ($p < 0.05$) greater than the coverage provided by Vests A and C. Vest B provided significantly ($p < 0.05$) more torso (back) coverage than vest C. Vest A provided significantly ($p < 0.05$) more shoulder coverage than Vest C. As mentioned earlier, the rear plate pocket of Vest C was not designed to be compatible with the strike plate utilized in the trial. Vest B provided significantly ($p < 0.05$) more coverage than Vest A or C.

In addition to the physical measures, participants also completed a coverage acceptability questionnaire. While the coverage provided by all three vest conditions was rated as being acceptable, the participants believed that the coverage provided by Vest B was too much and that Vest C provided too little coverage. The coverage provided by Vest C was significantly ($p < 0.05$) less acceptable than the coverage provided by Vest B in the shoulder and neck areas. Overall the coverage provided by Vest A was significantly ($p < 0.05$) more acceptable than the minimum coverage provided by Vest C or the maximum provided by Vest B. It should be noted that the soldiers did not properly landmark the front plates when wearing the vests.

4.5 Accessibility (See Annex E)

The ease and reliability of replacing the internal soft armour panels and auxiliary hard armour strike plates was evaluated for each vest design. Participants were required to remove completely and re-insert both the hard and soft armour components. HF observers evaluated the ease of accessibility and noted any installation errors.

The participants rated the ease and reliability of both soft and hard armour replacement as being acceptable for all vests conditions. The ease and reliability of replacing hard armour plates were rated higher than the ease and reliability of replacing soft armour panels. No accessibility differences were identified between the three vest conditions.

4.6 Range of Motion (See Annex F)

The degree to which each vest restricted the participant's range of motion was evaluated and compared to a non-fragmentation vest baseline. Each range of motion was tested four times: once in combat



clothing without a vest (No Vest) and then once for each of the three vest conditions. Range of motion was not evaluated while wearing load carriage systems or with strike plates.

As expected, the No Vest condition generally resulted in significantly greater ranges of motion than all other vest conditions for shoulder abduction, shoulder flexion, waist flexion and for neck extension. Vest B evidenced the poorest ranges of motion for shoulder abduction, shoulder flexion, waist flexion and for neck extension. There were significant differences ($p < 0.05$) between the range of motions between fragmentation vests.

4.7 Compatibility (See Annex G)

Compatibility with personal & crew served weapons, clothing and equipment was assessed with each vest condition. Additionally, compatibility with selected weapons and clothing items was also assessed by participants wearing the vest conditions with plates.

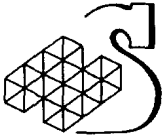
4.7.1 Weapons

Participants were required to rate the compatibility of each vest condition with the C7A1 rifle, C9 LMG, Carl Gustav and the M72 rocket launcher. Compatibility with the C7A1 and C9 LMG were also assessed with plates. Results for each vest and plate condition are described below.

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for C7A1 and C9 LMG compatibility without plates (*Barely to Reasonably Acceptable*). Vest A compatibility with the C7A1 while wearing plates was rated as being acceptable (*Borderline to Barely Acceptable*). Vest A was rated as being significantly ($p < 0.05$) more acceptable than Vest B for C9 LMG compatibility while wearing plates (*Borderline to Barely Acceptable*). Vest A was rated significantly ($p < 0.05$) more acceptable than Vest C for Carl Gustav compatibility (Number One Firer Only) without plates (*Barely to Reasonably Acceptable*). Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for M72 compatibility (*Reasonably to Completely Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for C7A1 and C9 LMG compatibility without plates (*Borderline*). Vest B compatibility with the C7A1 while wearing plates was rated as being unacceptable (*Borderline to Barely Unacceptable*). Vest B was rated as being significantly ($p < 0.05$) less acceptable than Vests A and C for C9 LMG compatibility while wearing plates (*Barely to Reasonably Unacceptable*). Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for Carl Gustav compatibility (Number Two -loader) without plates (*Barely to Reasonably Acceptable*). Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for M72 compatibility (*Barely to Reasonably Acceptable*). The excess material in the length of Vest B caused material bunching at the waist and in the upper back of participants, especially in the prone position. The cumbersome shoulder pads and elastic attachment strap also caused compatibility problems with Vest B.

Vest C: Vest C compatibility with the C7A1 while not wearing plates was rated as being acceptable (*Borderline to Barely Acceptable*). Vest C compatibility with the C7A1 while wearing plates was rated as being unacceptable (*Borderline to Barely Unacceptable*). Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for C9 LMG compatibility with and without plates (*Borderline to Barely to Acceptable*). Vest A compatibility with the C7A1 while wearing plates was rated as being acceptable (*Borderline to Barely Acceptable*). Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A for Carl Gustav compatibility (Number One Firer Only) without plates (*Borderline to*



Barely Acceptable). Vest C was rated significantly ($p<0.05$) more acceptable than Vest B for M72 compatibility (*Barely to Reasonably Acceptable*). Vest C suffered from shoulder and butt slippage problems with the weapons evaluated. Additionally, weapon compatibility with Vest C while wearing plates was problematic due to plate interference and vest instability.

4.7.2 Clothing and Equipment

Participants were required to rate the compatibility of each vest condition with the IECS Jacket, IECS Parka, and temperate combat gloves. Results for each vest condition are described below.

Vest A: Vest A was rated significantly ($p<0.05$) more acceptable than Vest B for IECS Jacket and IECS Parka compatibility (*Barely to Reasonably Acceptable and Borderline to Barely Acceptable*). Vest A compatibility with the in-service combat gloves was rated as being unacceptable (*Barely to Reasonably Unacceptable*). While Vest A was bulkier than Vest C, participants could still adjust their vest (shoulder and side straps) to fit overtop the IECS Jacket and bulky IECS Parka.

Vest B: Vest B was rated significantly ($p<0.05$) less acceptable than Vests A and C for IECS Jacket and IECS Parka compatibility (*Borderline to Barely Unacceptable and Barely to Reasonably Unacceptable*). Vest B compatibility with the in-service combat gloves was rated as being unacceptable (*Barely to Reasonably Unacceptable*). The bulkiness of Vest B and its one shoulder adjustment design made it problematic to wear with any jacket combination.

Vest C: Vest C was rated significantly ($p<0.05$) more acceptable than Vest B for IECS Jacket and IECS Parka compatibility (*Borderline to Barely Acceptable and Borderline to Barely Unacceptable*). Vest C compatibility with the in-service combat gloves was rated as being significantly more acceptable than Vests A and B (*Borderline*). Participants could adjust Vest C to fit overtop jackets and parkas if required. The design of vest C also allows it to be worn underneath the parka while the fixed collar of Vest A and the fixed collar and shoulder's of Vest B make this difficult.

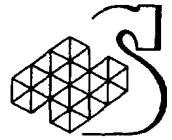
4.7.3 Vehicles

Compatibility of the subjects with the MLVW and Bison vehicles was assessed with each vest condition. Compatibility with the MLVW was also assessed with participants wearing vests with plates.

Vest A: Vest A was rated significantly ($p<0.05$) more acceptable than Vest B for MLVW compatibility with and without plates (*Barely to Reasonably Acceptable and Reasonably to Completely Acceptable*). Vest A was rated significantly ($p<0.05$) more acceptable than Vest B for Bison compatibility without plates (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p<0.05$) less acceptable than Vests A and C for MLVW compatibility with and without plates (*Barely Unacceptable to Borderline and Borderline to Barely Acceptable*). Vest B was rated significantly ($p<0.05$) less acceptable than Vests A and C for Bison compatibility without plates (*Barely Unacceptable to Borderline*).

Vest C: Vest C was rated significantly ($p<0.05$) more acceptable than Vest B for MLVW compatibility with and without plates (*Barely to Reasonably Acceptable*). Vest C was rated significantly ($p<0.05$) more acceptable than Vests B for Bison compatibility without plates (*Barely to Reasonably Acceptable*).



4.8 Combat Activities (See Annex H)

Combat activity performance was evaluated with the three fragmentation vests during obstacle course trials, grenade throwing, vehicle inspection and casualty evacuation stands.

4.8.1 Obstacle Course

Participants were required to complete a series of CF standard obstacles in rapid succession as a member of a section. Upon completion of each vest condition participants were required to complete an Obstacle Task Questionnaire. All participants traversed the obstacle course in combat clothing at first to practice individual obstacle breaching and to establish a baseline level of performance to evaluate the effects of fragmentation vest wear.

Overall, Vest B was rated as being unacceptable for the obstacle course task and was significantly ($p < 0.05$) less acceptable than the No Vest condition or Vests A and C. Vests A and C were rated as being acceptable for performance of the obstacle course battle task. Select obstacle course task questionnaire results are summarized below:

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for Overall Manoeuvrability, Overall Ease of Obstacle Traverse, Overall Range of Motion, and Overall Task Performance (*Borderline to Barely Acceptable*). Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for Suitability for Field Use (*Barely to Reasonably Acceptable*).

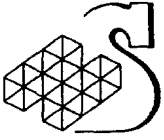
Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A and C for Overall Manoeuvrability, Overall Range of Motion, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Unacceptable*). Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for Ease of Obstacle Traverse (*Borderline to Barely Unacceptable*).

Vest C: Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for Overall Manoeuvrability, Overall Range of Motion, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Acceptable*).

4.8.2 Grenade Throw

Participants were required to throw a dummy grenade in each fragmentation vest/load carriage condition assigned into a target circle (6 meter diameter) from a prone position at a distance of 15 meters. Participants indicated a performance rating score for each condition. Due to the hard surface of the target area, the dummy grenades thrown frequently rolled out of the target zone and thus were not representative of the accuracy achievable on a grassed surface. As a result grenade throwing accuracy was not recorded.

Vest B was rated as being unacceptable (*Borderline to Barely Unacceptable*) for the grenade throwing task and was rated significantly ($p < 0.05$) less acceptable than Vests A and C. Vest A was rated as being acceptable (*Barely to Reasonably Acceptable*) for the grenade throwing task. Vest C was also rated as being acceptable (*Borderline to Barely Acceptable*) for the grenade throwing task. While grenade throwing performance was somewhat reduced while wearing any fragmentation vest, the bulk of Vest B and its restrictions to shoulder and neck movement greatly affected the participants acceptability ratings.



4.8.3 Vehicle Inspection

Participants were required to perform a simulated vehicle inspection. This drill was designed to simulate the civilian vehicle inspection procedures required during peacekeeping roadblock checkpoints. Inspection activities included a standing inspection of the exterior bodywork, kneeling inspection of a wheel well, prone inspection of the car underside below the trunk, and stooped/crouched inspection of the passenger seat area. For all fragmentation vest/fighting order conditions, participants were required to rate the ease of vehicle inspection activities.

Vest B was rated as being unacceptable (*Borderline to Barely Unacceptable*) for the vehicle inspection task and was rated significantly ($p < 0.05$) less acceptable than Vests A and C. Vest A was rated as being acceptable (*Barely to Reasonably Acceptable*) for the vehicle inspection task. Vest A was rated significantly ($p < 0.05$) more acceptable than Vest C. Vest C was also rated as being acceptable (*Barely to Reasonably Acceptable*) for the vehicle inspection task. While vehicle inspection performance was somewhat reduced while wearing any fragmentation vest, the bulk of Vest B and its restrictions to shoulder and neck movement greatly affected the participants' acceptability ratings.

4.8.4 Casualty Handling

Working in pairs, participants were required to simulate vest removal from a prone, injured soldier. Participants rated the ease of removal, both as the first aid provider and the injured participant. HF observers also evaluated the ease of vest removal and the extent of injured soldier movement/handling required.

All vest conditions were rated as being acceptable for casualty extraction. Vest B was rated as being significantly ($p < 0.05$) less acceptable than Vests A and C for casualty extraction (*Reasonably to Completely Acceptable*). Vest C was also rated as being acceptable (*Barely to Reasonably Acceptable*) for the casualty handling task. The two shoulder adjustment features of Vests A and C made it much easier to extract casualties from their vest as compared to Vest B which had one fixed shoulder. The locking Velcro flap on Vest C's shoulder strap required more effort to release as compared to the non-locked Velcro shoulder strap of Vest A.

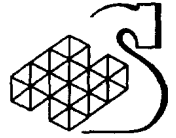
4.9 Range Firing (See Annex I)

Range firing was undertaken to evaluate the compatibility effects of the three vest conditions for the C7A1 rifle and the C9 LMG.

4.9.1 C7A1 Rifle

Participants performed a modified Personal Weapons Test (PWT) with the C7A1 rifle in each vest condition. The modified programme including a preliminary zeroing serial followed by a scored grouping test and then a modified run-down test. Following each set of range firing serials, participants completed a C7 Range Firing Task Questionnaire. Range scores were recorded for each weapon and vest condition. Additionally, eight infantrymen repeated the firing serials while wearing plates with the three vest conditions.

An analysis of the range firing scores did not identify any significant difference between any of the fragmentation vest conditions, even with or without plates. While the infantrymen had less variability in their range scores than the combined trial personnel, the differences between vests were not significant.



Overall, Vest B was rated as being unacceptable for the C7A1 Rifle Firing Task and was significantly ($p<0.05$) less acceptable than the No Vest condition or Vest A. The No Vest, Vest A and Vest C conditions were rated as being acceptable for C7A1 rifle firing. Select C7 Range Firing Task Questionnaire results are summarized below:

Vest A: Vest A was rated significantly ($p<0.05$) more acceptable than Vests B for Suitability for Field Use and Overall Rifle Firing Performance (*Borderline to Barely Acceptable*). Vest A was also rated acceptable for Overall Compatibility and Overall Task Performance (*Borderline to Barely Acceptable*). Some concerns with weapon butt plate slippage were noted with Vest A.

Vest B: Vest B was rated significantly ($p<0.05$) less acceptable than Vest A for Overall Rifle Firing Performance, Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Unacceptable*). Participants noted problems with vest bulk, excessive vest length, neck discomfort, and shoulder pad slippage.

Vest C: Vest C was rated significantly ($p<0.05$) less acceptable than Vest A for Overall Rifle firing Performance (*Borderline to Barely Unacceptable*). Vest C was also rated acceptable for Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Acceptable*). A number of subjects had problems finding a stable rifle butt position in the prone position.

4.9.2 C9 LMG

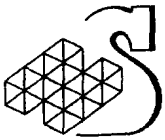
Participants performed a familiarization shoot with the C9 LMG in each vest condition. Following each set of range firing serials, participants completed a C9 LMG Range Firing Task Questionnaire. Range scores were not recorded.

All vest conditions were rated as being acceptable for C9 LMG Firing. Overall, Vest B was rated as being significantly ($p<0.05$) less acceptable than Vests A and the No Vest condition for the C9 LMG battle task. Vests A and C were also rated as being significantly ($p<0.05$) less acceptable than the No Vest condition for the C9 LMG battle task. Select C9 LMG Range Firing Task Questionnaire results are summarized below:

Vest A: Vest A was rated significantly ($p<0.05$) more acceptable than Vests B and C for Overall C9 LMG firing, Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Barely to Reasonably Acceptable*). Vest A was also rated acceptable for Overall Compatibility and Overall Task Performance (*Borderline to Barely Acceptable*). Some concerns with weapon butt plate positioning were noted with Vest A.

Vest B: Vest B was rated significantly ($p<0.05$) less acceptable than Vest A for Overall Rifle Firing Performance, Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Unacceptable*). Participants noted problems with vest bulk, excessive vest length, neck discomfort, and shoulder pad placement.

Vest C: Vest C was rated significantly ($p<0.05$) less acceptable than Vest A for Overall C9 LMG Firing Performance (*Borderline to Barely Unacceptable*). Vest C was also rated acceptable for Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Acceptable*).



4.10 Battle Tasks (See Annex J)

Participants performed two battle task serials (section fire and movement and FIBUA house clearing) to evaluate the effect of the different vests on perceived fighting effectiveness during realistic simulations of combat operations. Participants were divided into three sections consisting of a Section Commander who was a non-participant trial NCO, six riflemen and two C9 gunners. Previously, all the participants had observed a fire & movement and a house clearing demonstration and then had practised the tactical drills. The battle tasks were performed in a tactical setting as a platoon organization.

For the combined battle task, Vests A (*Barely to Reasonably Acceptable*) and Vest C (*Borderline to Barely Acceptable*) were rated as being acceptable. Vest B was rated as being unacceptable for the overall battle task (*Borderline to Barely Unacceptable*). Overall, Vest B was rated as being significantly ($p<0.05$) less acceptable than Vests A and C for the battle tasks. Vests A and C were also rated as being significantly ($p<0.05$) less acceptable than the No Vest condition for the battle task. Vest B was rated as being unacceptable for Field Use (*Borderline to Barely Unacceptable*) and was significantly less acceptable than Vests A and C. Separate and select Battle Task Questionnaire results are summarized below:

4.10.1 Fire and Movement

The fire and movement drill was performed in open ground in the training area at CFB Petawawa adjacent to the FIBUA site. The drill involved the platoon advancing along a trail and upon entering a clearing was engaged by a separate enemy force. Upon contact the lead two sections cleared the forward two enemy trenches while the depth section cleared the enemy's depth trench. Results for each vest condition are described below.

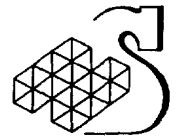
Vest A: Vest A was rated significantly ($p<0.05$) more acceptable than Vests B for Overall Manoeuvrability and Fire & Movement (*Barely to Reasonably Acceptable*). Except for speed of movement, Vest A was also rated significantly ($p<0.05$) more acceptable than Vest B for all unique fire and movement questions (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p<0.05$) less acceptable than Vests A and C for Overall Manoeuvrability and Fire & Movement (*Borderline to Barely Unacceptable*). Except for speed of movement and accessing magazines, Vest B was also rated significantly ($p<0.05$) less acceptable than Vests A and C for all unique fire and movement questions (*Barely Acceptable to Barely Unacceptable*).

Vest C: Vest C was rated significantly ($p<0.05$) more acceptable than Vests B for Overall Manoeuvrability and Fire & Movement (*Barely to Reasonably Acceptable*). Except for accessing magazines, Vest C was also rated significantly ($p<0.05$) more acceptable than Vest B for all unique fire and movement questions (*Barely to Reasonably Acceptable*).

4.10.2 House Clearing

Upon the completion of the fire and movement section attack phase of the battle task, the depth section provided a fire-base for the one-story building's entry at the nearby FIBUA training complex. Once the first building was secure the platoon broke into the second two-story building and cleared it by leapfrogging sections forward. An active enemy force was provided by trial support staff. The



participants utilized mouse holes in the walls and ceilings (with ropes) to move through the two-story building. Results for each vest condition are described below.

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vests B for Overall Stability and Suitability for FIBUA operations (*Barely to Reasonably Acceptable*). Except for bulk, Vest A was also rated significantly ($p < 0.05$) more acceptable than Vest B for all FIBUA questions (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for Stability and Vest A for FIBUA operations (*Borderline to Barely Unacceptable*). Except for vest fit, bulk, stiffness Vest B was also rated significantly ($p < 0.05$) less acceptable than Vests A and C for all unique FIBUA questions (*Barely Acceptable to Reasonably Unacceptable*).

Vest C: Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A for Overall FIBUA ratings, fit, and vest stiffness (*Borderline to Barely Acceptable*). Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for Stability (*Borderline to Barely Acceptable*). Except for vest fit, bulk, and stiffness, Vest C was also rated significantly ($p < 0.05$) more acceptable than Vest B for all other FIBUA questions (*Barely to Reasonably Acceptable*).

4.11 Comfort (See Annex K)

After the C7A1 run down serials and the fire and movement serials, the participants completed both a Physical and Thermal Comfort Questionnaire. It should be noted that the weather was typical autumn weather with cool overcast conditions. While the tasks were short in duration – approximately 45 minutes long, they were physically demanding. Combined task results for physical and thermal comfort are reported separately below.

4.11.1 Physical Comfort

Physical discomfort results are summarized below for the front and back of the body.

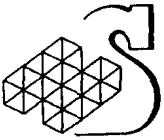
Front: Shoulder and neck discomfort were the most commonly reported problems with all three vests. Vest A evidenced significantly ($p < 0.05$) higher shoulder discomfort than Vest B (Right Shoulder) and Vest C (Right and Left Shoulders). Vest B evidenced significantly ($p < 0.05$) higher neck discomfort (Slight Discomfort) than Vests A and C.

Vests A and B were rated as having significantly ($p < 0.05$) more Abdomen discomfort as compared to Vest C. Except for Vest B's neck discomfort rating, the discomfort levels reported with any Vest were between none and only slight.

Back: Vest B evidenced significantly ($p < 0.05$) higher neck discomfort (Slight Discomfort) than Vests A and C. Vests A was rated as having significantly ($p < 0.05$) more Abdomen discomfort as compared to Vests B and C. Except for Vest B's neck discomfort rating, the discomfort levels reported with any Vest were between none and only slight.

4.11.2 Thermal Comfort

Thermal discomfort results are summarized below for the front and back of the body



Front: Chest thermal discomfort was reported by most of the participants for all three vests (*Slightly Warm to Warm*). Next to the chest region, the abdomen suffered the next highest percentage of discomfort (*Neutral to Slightly Warm*). There were significant differences between Vest A and C for the thermal comfort associated with the right and left shoulder.

Back: Lower and upper back thermal discomfort was reported by most participants for all three vests at similarly moderate levels of thermal stress (*Slightly Warm to Warm*). There were no significant differences between vests for regions of thermal discomfort.

It should be noted again that the weather conditions during the trial were cool and overcast and thus the thermal discomfort results may not be indicative of results to be expected in warmer temperatures.

4.12 Exit Focus Group (See Annex L)

A focus group was held at the completion of the trial to allow subjects to perform a direct comparison of all three vests, rate specific vest features, rate feature preferences, rate criteria of importance and as a group, discuss their reasons for specific vest preferences and suggestions for future improvements. Participants were issued the following Questionnaires:

- Features Questionnaire (for each vest)
- Feature Preference Questionnaire
- Criteria of Importance Questionnaire
- Exit Questionnaire (Without Plates)
- Exit Questionnaire (With Plates)

Following the completion of the questionnaire battery, a focus group discussion was held to determine which vest was preferred by the participants for the exit questionnaire human factors (HF) criteria. Finally suggestions on improving the recommended vest design were discussed.

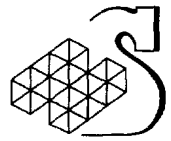
4.12.1 Features Questionnaire

Participants were asked to rate the functionality and durability of the various design features incorporated in the three different vest designs. Results of the participant ratings are described below for each vest.

Vest A: The durability and functionality of the features incorporated in Vest A were all rated as acceptable. The durability of Vest A's elastic straps, snaps and Velcro were a concern to a number of subjects.

Vest B: The participants rated the majority of Vest B's features as being unacceptable for functionality or durability. The collar design of Vest B was rated as being *Barely to Reasonably Unacceptable* for functionality. The shoulder pad, single shoulder adjustment, side adjustment and waist belt design features were all rated as being unacceptable (*Borderline to Barely Unacceptable*). Subjects did rate the ballistic plate pockets as being *Reasonably Acceptable* for functionality and durability.

Vest C: The durability and functionality of the features incorporated in Vest C were all rated as acceptable. The durability of Vest C's elastic straps, snaps and Velcro were a concern to a number of subjects.



4.12.2 Features Preferences

The questionnaire addressed preferences for specific fragmentation vest features. In each case, the preference scale was balanced, with increasing preference ratings to each end of the scale from a neutral centre point. Each end of the scale comprised two different or opposite aspects of a particular vest design feature. Summary descriptive results (mean, minimum rating, maximum rating, and standard deviation) are depicted in Figure 4 below. Features have been arranged in order of strongest to weakest preference.

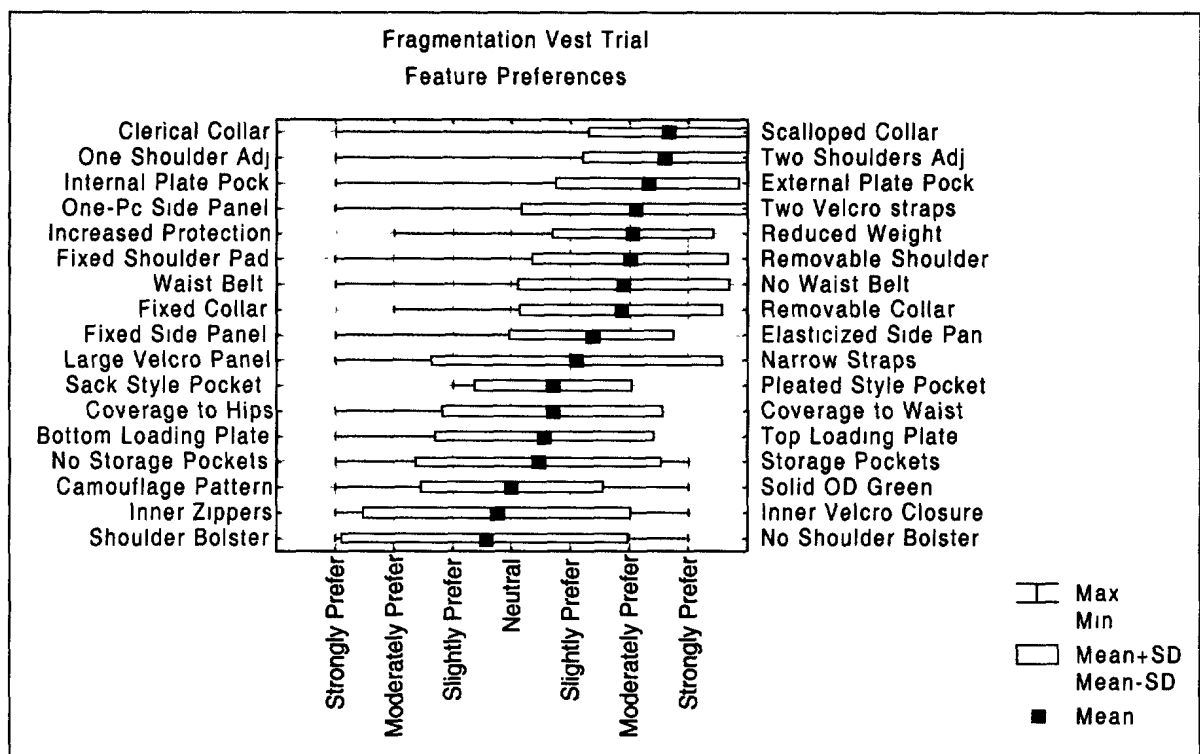


Figure 4: Feature Preferences

4.12.3 Criteria of Importance

A Criteria of Importance questionnaire was administered at the end of testing during the Exit Focus Group. Participants rated the perceived importance of various design criteria for selecting or assessing a fragmentation vest. Participants ranked each criterion using a seven-point scale of importance. These ratings were then used to produce a criterion of importance ranking. Summary descriptive results (mean, standard deviation) are depicted in Figure 5 below. Criteria have been generally arranged in order of strongest to weakest importance.

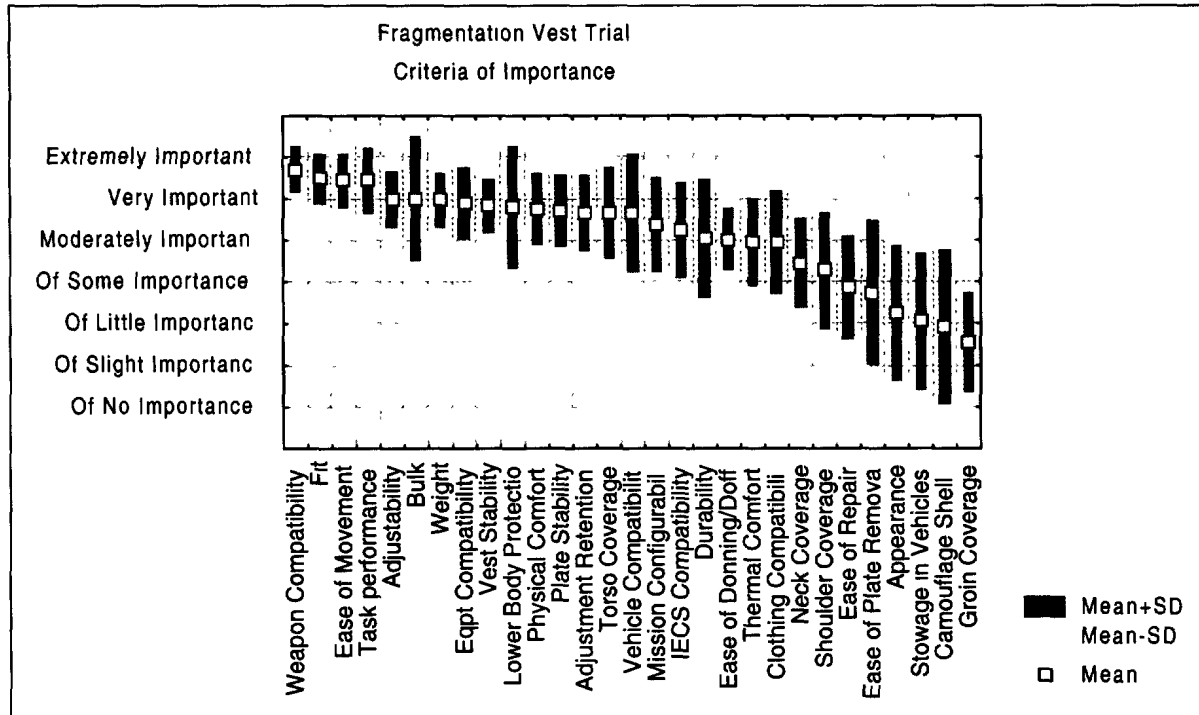
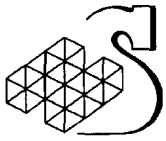


Figure 5: Criteria of Importance Questionnaire Results

4.12.4 Exit Questionnaire

Participants were issued two similar Exit Questionnaires comparing all three vest conditions against a number of HF criteria. Separate questionnaires were issued to allow for a direct vest comparison both with and without plates.

4.12.4.1 Exit Questionnaire without Plates

Overall, Vest A was rated significantly more acceptable than Vests C and B (*Reasonably Acceptable*). Vest C was also rated significantly more acceptable than Vest B overall (*Borderline to Barely Acceptable*). Overall, Vest B was rated as being unacceptable (*Reasonably Unacceptable*). Results for each vest condition are displayed below in Figure 6.

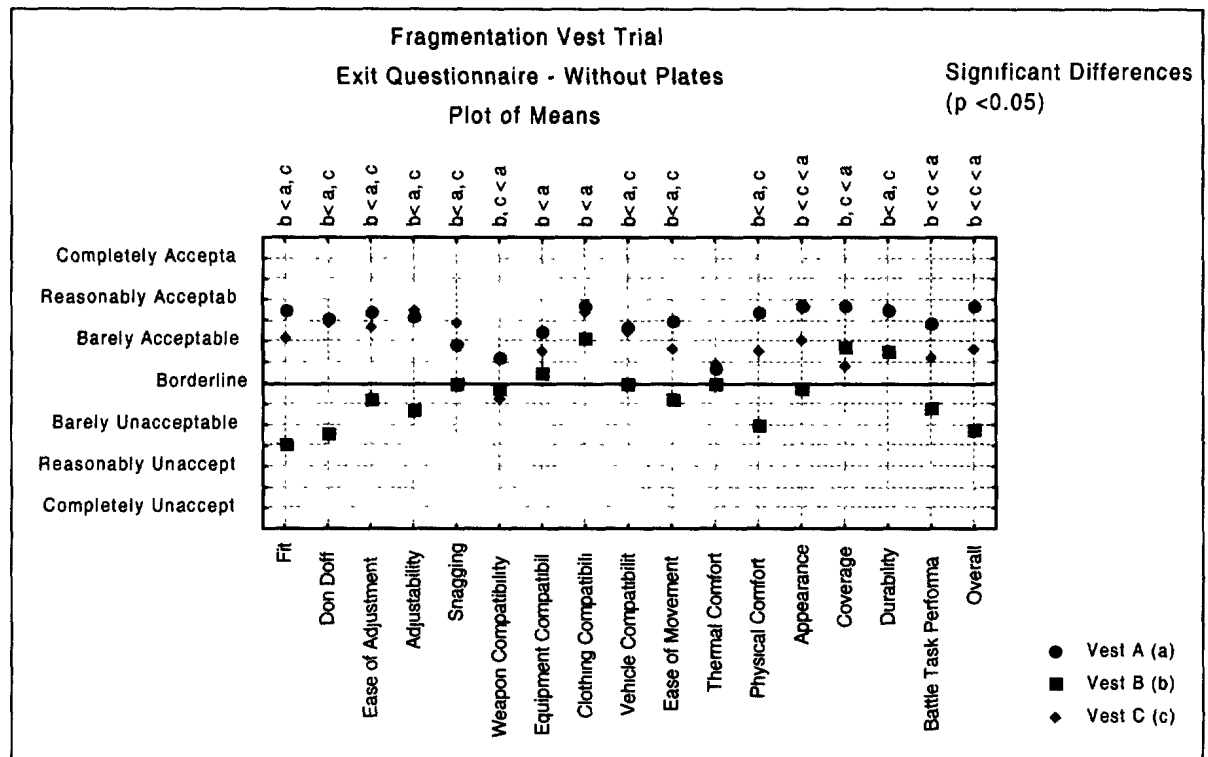
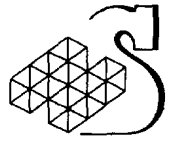


Figure 6: Exit Questionnaire (Without Plates) Results

4.12.4.2 Exit Questionnaire with Plates

Overall, Vest A was rated significantly more acceptable than Vests C and B (*Reasonably Acceptable*). Vest C was also rated significantly more acceptable than Vest B overall (*Borderline to Barely Acceptable*). Overall, Vest B was rated as being unacceptable (*Reasonably Unacceptable*). Results for each vest condition are displayed below in Figure 7.

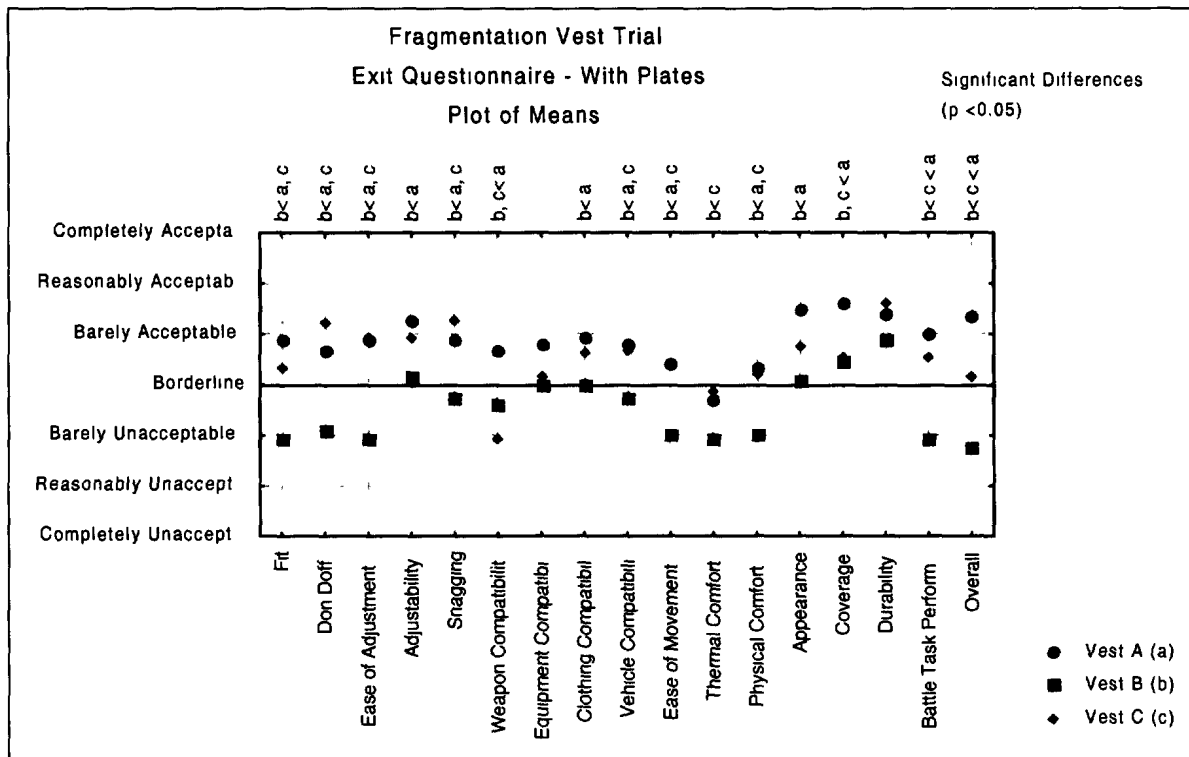
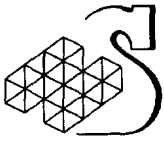
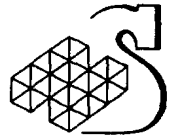


Figure 7: Exit Questionnaire (With Plates) Results

4.12.5 Exit Focus Group

During the focus group discussion participants were required to vote for the vest they most preferred for each of the human factors (HF) criteria, and then describe the reasons for their preference in a group discussion

Participants indicated a strong and consistent preference for Vest A over Vests B and C for most HF criteria. Conversely, participants indicated a strong and consistent dislike of Vest B in most HF criteria. Overall, 17 of the 23 participants indicated that Vest A was the best vest evaluated, while six subjects indicated that Vest C was the best vest evaluated. None of the participants felt that Vest B was acceptable for operational fielding.



5. Discussion

A controlled human factors (HF) field trial evaluation of three prototype fragmentation vests (i.e Vests A, B and C) was undertaken to determine the most suitable design for future Canadian Forces (CF) procurement. The primary aim of this field trial was to evaluate the human factors (HF) suitability of two prototype fragmentation vest designs, by comparison with the original Generation II design.

Data collection focussed on the following HF criteria.

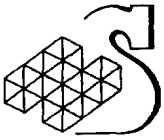
- Anthropometry
- Fit/Adjustability
- Protective Coverage
- Accessibility
- Casualty Evacuation
- Range of Motion
- Clothing/Equip. Compatibility
- Vehicle Compatibility
- C7 and C9 Range Firing
- Grenade Throwing
- Vehicle Inspection
- Battle Task Performance
- Thermal Load
- Physical Comfort
- User Acceptance
- Features

Both Vest A and C were rated as acceptable and more favourable than Vest B. Vest B was rated as being significantly less acceptable than Vest A and C in most aspects. Vest B was also rated as being unacceptable for field use in a number of aspects. Overall trial participants selected Vest A (74%) and Vest C (26%) as the best vests trialled. The participants were unanimous and unequivocal in their dislike of Vest B.

5.1 Fragmentation Vest Design Preferences

Each of the prototype fragmentation vests was evaluated on an extensive battery of HF criteria. Inspection of the questionnaire data and focus group comments suggested that participant perceptions were influenced by a number of factors. When asked which were the most important factors (criteria) for selecting a new fragmentation vest, the participants rated four criteria in the highest importance category: Weapon Compatibility, Fit, Ease of Movement, and Task Performance. As discussed in Annex L, this ranking of criteria of importance was shaped by the users experience both during the trial and on previous operations and was based on the environmental conditions during the trial. Had the trial been hotter, thermal comfort may have been more influential.

The suitability of the three prototype vests against the four most influential criteria are summarized below to illustrate the underlying differences between vests



Weapon Compatibility

The excess material in the length of Vest B caused material bunching at the waist and in the upper back of participants, especially in the prone position. These design features and the cumbersome shoulder pads and shoulder elastic attachment strap caused compatibility problems for Vest B with the C7A1 rifle, C9 LMG, M72, and Carl Gustav during static testing. Vest B was rated significantly less acceptable than Vest A in the C7A1 and C9 LMG Range Firing stand for Overall Weapon Firing performance, Overall Compatibility, Overall Task Performance and Suitability for Field Use. Participants noted problems with vest bulk, excessive vest length, neck discomfort and rifle butt slippage at the shoulder. While rifle butt slippage was also noted with Vests A and C, Vest C suffered from notable rifle butt slippage. In contrast, participants reported few concerns with Vest A.

Fit

Overall, the male and female participants achieved an acceptable fit with each of the three vest conditions. The participants did rate Vest A and C significantly ($p < 0.05$) more acceptable than Vest B for overall fit and adjustability. The excess material in the length of Vest B caused material bunching at the waist and in the upper back of participants. The design of the collar of vest B resulted in a tight “choking” collar; the design caused chaffing problems and considerable neck discomfort. Vests A and C provided a range of waist and chest adjustments through the use of elastic side straps and overlapping panels. Vest B’s design was tubular in shape and had limited adjustability. Fit adjustments with Vest B were problematic and usually required the assistance of another participant. The one-shoulder opening design of Vest B limited its ability to acceptably accommodate extra jackets or layers when worn underneath the vest. Conversely, participants believed they could achieve a good fit with Vests A and C.

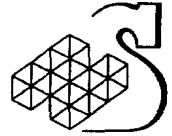
Ease of Movement

As noted in earlier trials, ease of movement was one of the most critical HF criteria for performing infantry operations, both mounted and dismounted. While any fragmentation vest will reduce freedom of movement, the problems caused by Vest B were notable. The long cut of the torso, the bulky design, the non-elasticized sides and the cumbersome shoulder pad design resulted in a vest design which greatly restricted ease of movement in many tasks. Vest B was rated significantly less acceptable than Vests A and C for range of motion, obstacle traverse, grenade throwing, vehicle inspection, and casualty handling. More significantly, Vest B was rated as being unacceptable for the combined battle task. The key area for Vest B’s failure was “Overall Manoeuvrability”. While Vest C was a concealable vest design with the lowest coverage provided, a number of participants noted that it was stiff in the front. This was due to the fact that the front ballistic panel was salvaged from two half panels and had a number of layers of reinforcing material. The extra material and sewing made the front panel stiffer than the new material in Vest A and B.

Task performance

Task performance included weapon handling tasks, range firing, vehicle access, casualty access and battle tasks – section fire and movement and FIBUA operations. Vest B generally rated less acceptable than Vest A and C for all these tasks. Participants could not handle their weapons properly, skirmish or move as easily as required, nor could they access vehicle hatches properly. In contrast, participants had fewer concerns with Vest A or C.

In summary, participants preferred a vest design which fit properly, gave them adequate protection, offered little restriction to movement, was comfortable, provided multiple and easy adjustment points,

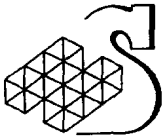


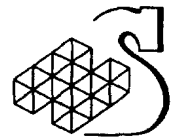
did not inadvertently snag, and was compatible with their tasks and duties. Vest A best matched the subjects preferences and criteria of importance.

While Vest A was selected by 74% of the subjects as being the best vest trial, a significant number 26% felt Vest C was the best vest trialled and suitable for field issue. Considering that Vest A was a refinement of Vest C, a closer examination of why this difference in opinion occurred was explored. Supporters of Vest C championed the removable collar and underarm cut of Vest C over Vest A. They believed that the removable collar made the vest particularly suitable for use inside armoured vehicles and compatible for wearing underneath jackets and parkas. While Vest C proponents found the design of Vest A as being acceptable, the freedom of movement and mission configurability built into Vest C was key. Both Vest A and C proponents felt that Vest B was unacceptable for field use. Proponents of Vest A pointed to the extra coverage provided and its balance between manoeuvrability and protection. When asked to suggest changes to Vest A to make it more acceptable, the subjects recommended features and design changes that combined the designs of Vest A and C.

5.2 Further Work

While this controlled HF field trial was comprehensive, only one length of vest was available for trialling. A detailed fit test should be undertaken to determine tariffing and fit boundaries. As well, the female participants in the trial were not representative of the Land Force females for bust sizes. The need for female specific designs should be addressed in future investigations.





6. Recommendations

Based on the results of this controlled HF field trial of prototype fragmentation vests, we recommend that the Pacific Body Armour Generation III design (Vest A) be selected for further refinement and procurement by the Canadian Forces (CF). The design modifications recommended include:

Remove some material around the arm openings. Participants requested the removal of material from Vest A to closer resemble the arm openings on Vest C. Removal of a small amount of material will enhance freedom of movement without adversely affecting coverage too much. The large arm opening of Vest C however, was associated with plate compatibility and stability problems and thus any reduction should be limited to 1.2 cm.

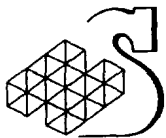
Provide a removable collar. Participants wish to have the freedom of removing the collar to enhance task and clothing compatibility.

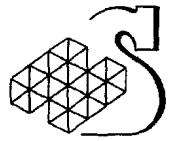
Change the Shoulder Pad Retention Strap to prevent inadvertent twisting. Presently, Vest A's shoulder pad design becomes bunched and twisted during fragmentation and assault vest donning procedures. Changing the shoulder pad retention design or making the retention strap wider and stiffer may alleviate this problem.

Provide slip resistant material on shoulder pads and butt rest points. Participants noted C7A1 rifle butt slippage with Vest A as well as some M72 and Carl Gustav slippage on the shoulders. Providing a slip resistant material may help prevent weapon slippage as well the associated 82-Pattern webbing shoulder strap slippage.

Provide stiffer side adjustment straps. Participants requested stiffer side straps to assist in donning procedures. The current straps frequently tangle and are awkward to grab.

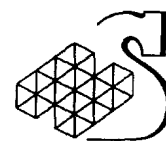
Lengthen the length of Side Adjustment Strap Velcro pile on the front of the vest. The side adjustment straps are currently too long for some subjects. Thus, the ends of the straps are not secured to the vest and cause snagging problems.





**Annex A:
Fragmentation Vests**

**ANNEX A:
Fragmentation and Load Carriage Vests**



Annex A: Fragmentation Vests

1. Introduction

This Annex includes a labeled line drawing of the front and the back of each of the three vests evaluated: Vest A, Vest B and Vest C.

Figure 1: Vest A (Front View)

Figure 2: Vest A (Back View)

Figure 3: Vest B (Front View)

Figure 4: Vest B (Back View)

Figure 5: Vest C (Front View)

Figure 6: Vest C (Back View)

This Annex also includes a labeled line drawing of the front and the back of each of the two load carriage systems evaluated: 82 pattern webbing and the Tactical Assault Vest (TAV)

Figure 7: 82 Pattern webbing

Figure 8: TAV (Front View)

Figure 9: TAV (Back View)



Annex A: Fragmentation Vests

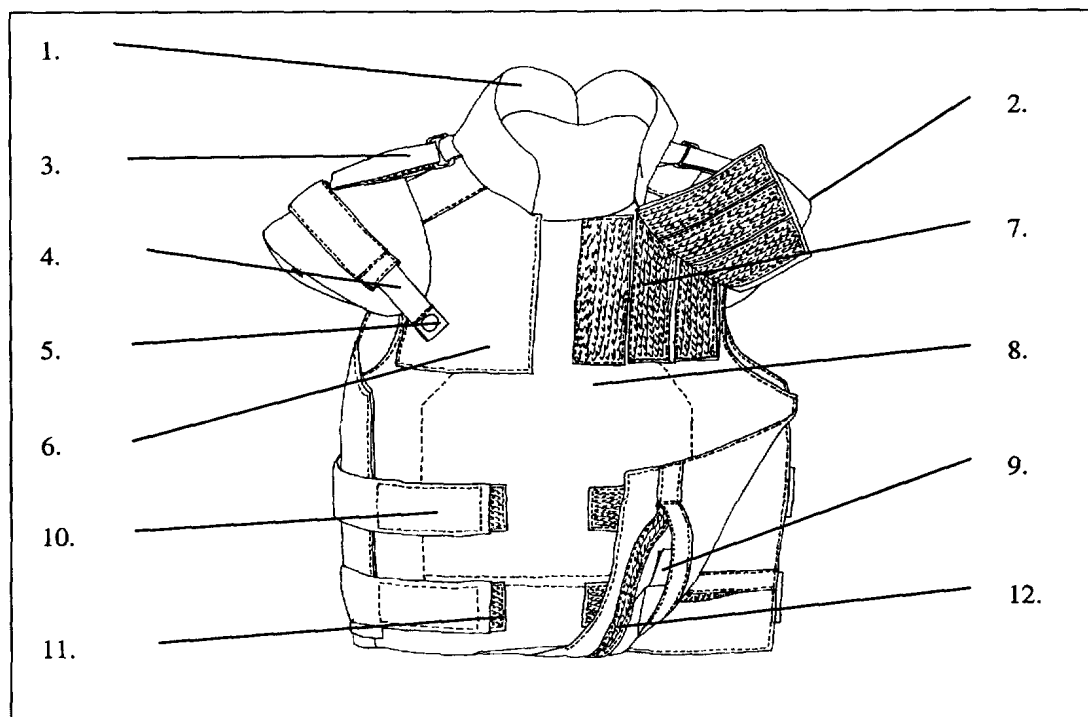
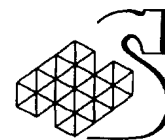


Figure 1: Vest A (Front View)

VEST A FEATURES	
1.	Collar
2.	Shoulder Pad
3.	Shoulder Pad Strap
4.	Shoulder Pad Elastic
5.	Shoulder Pad Strap
6.	Shoulder Adjustment
7.	Shoulder Adjustment Velcro
8.	Front Plate Pocket
9.	Front Plate Pocket Velcro
10.	Side Adjustment
11.	Side Adjustment Velcro
12.	Panel Pocket Velcro



Annex A: Fragmentation Vests

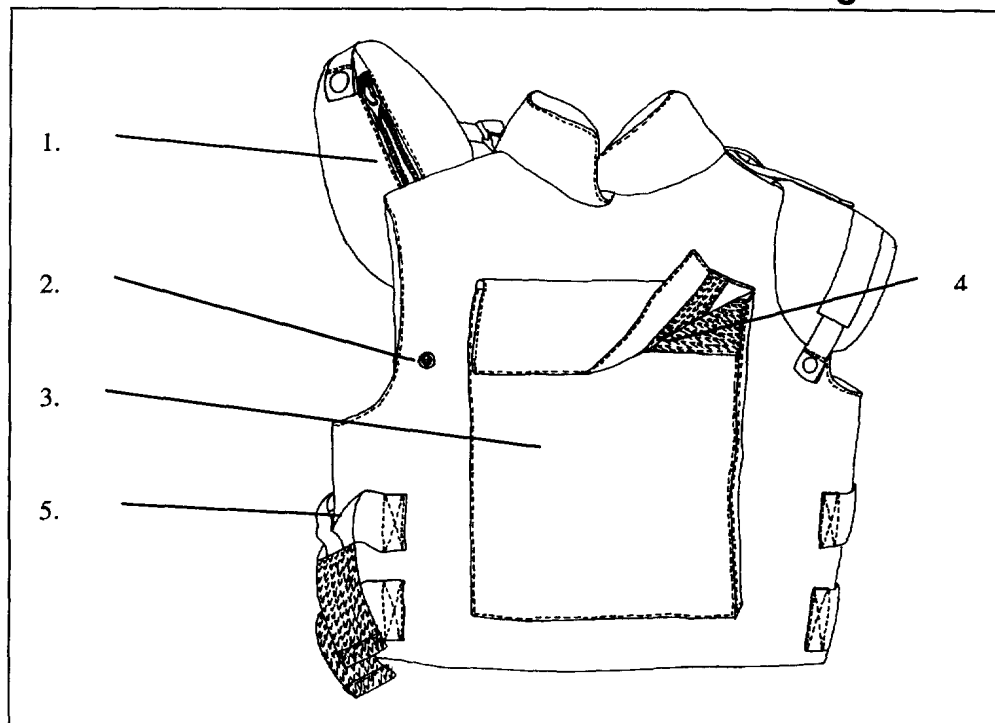


Figure 2: Vest A (Back View)

FEATURES	
1.	Shoulder Pad Panel Pocket Velcro
2.	Shoulder Pad Snap (Back)
3.	Rear Plate Pocket
4.	Rear Plate Pocket Velcro
5.	Side Elastic Limiter Strap
6.	Side Strap Pull Tab (Not Shown)



Annex A: Fragmentation Vests

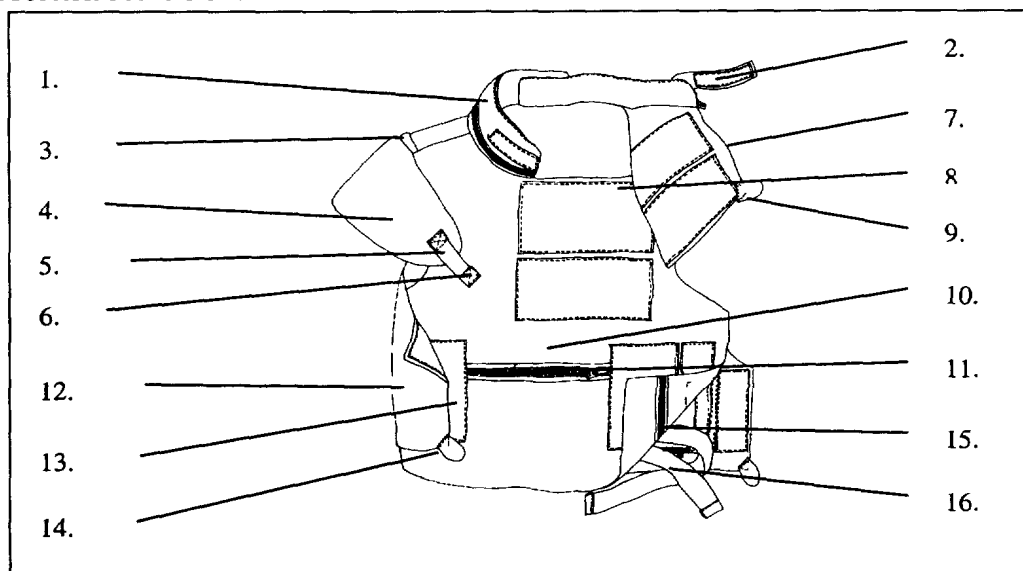


Figure 3: Vest B (Front View)

FEATURES	
1.	Collar
2.	Collar Velcro Closure
3.	Shoulder Bolster
4.	Shoulder Pad
5.	Shoulder Pad Elastic
6.	Shoulder Pad Snap (Front)
7.	Single Shoulder Adjustment
8.	Shoulder Adjustment Velcro
9.	Shoulder Adjustment Pull Tab
10.	Front Plate Pocket
11.	Front Plate Pocket Zipper
12.	Side Adjustment
13.	Side Adjustment Velcro
14.	Side Adjustment Pull Tab
15.	Panel Pocket Zipper
16.	Waist Belt



Annex A: Fragmentation Vests

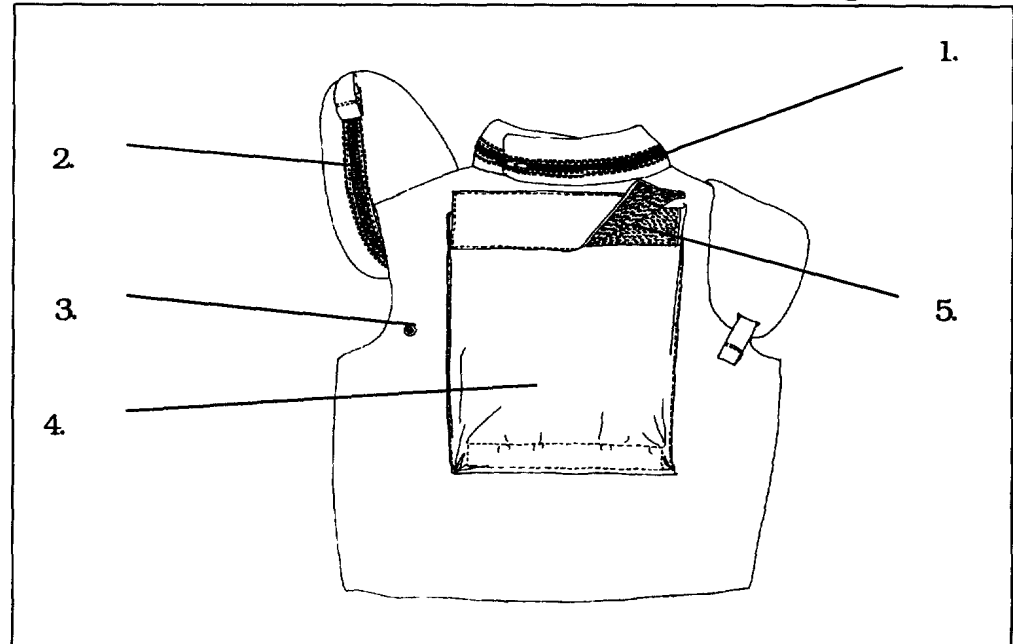
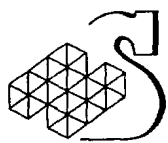


Figure 4: Vest B (Back View)

FEATURES
1. Collar Panel Zipper
2. Shoulder Pad Panel Pocket Zipper
3. Shoulder Pad Snap (Rear)
4. Rear Plate Pocket
5. Rear Plate Pocket Velcro



**Annex A:
Fragmentation Vests**

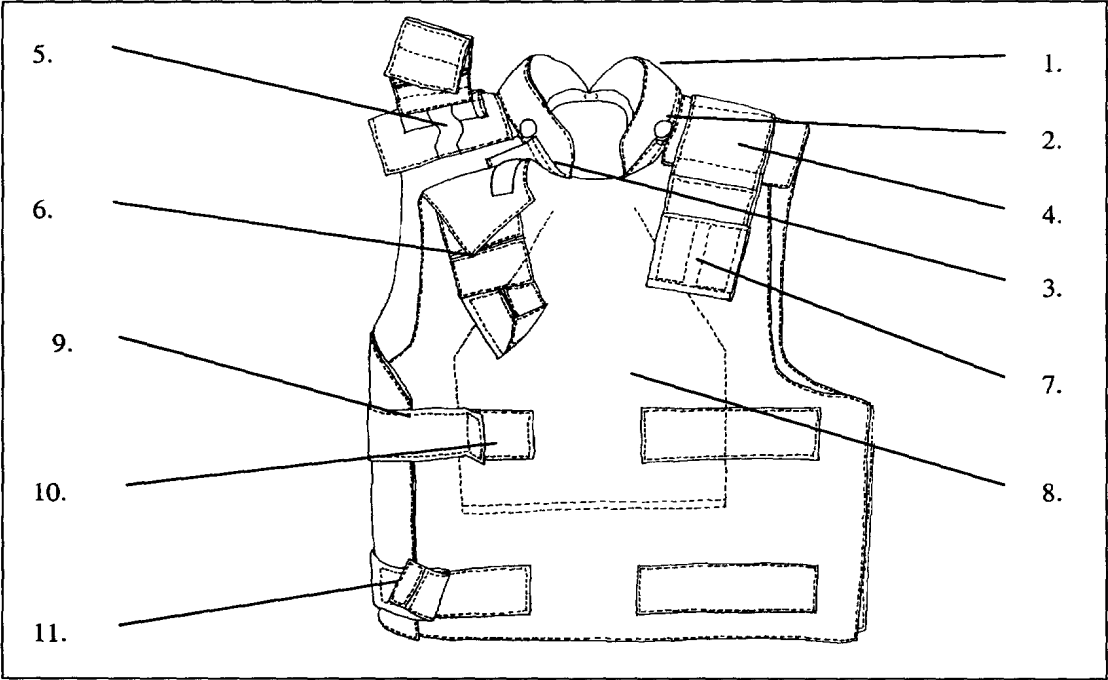
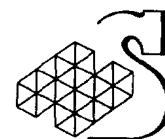


Figure 5: Vest C (Front View)

FEATURES	
1.	Collar
2.	Collar Snap
3.	Collar Velcro
4.	Shoulder Pad Strap
5.	Shoulder Pad Limiter Strap
6.	Shoulder Pad Adjustment Velcro
7.	Shoulder Pad Velcro Locking Strap
8.	Front Plate Pocket
9.	Side Adjustment Strap
10.	Side Adjustment Velcro
11.	Side Strap Pull Tab
12.	Panel Pocket Velcro (Not Shown)



**Annex A:
Fragmentation Vests**

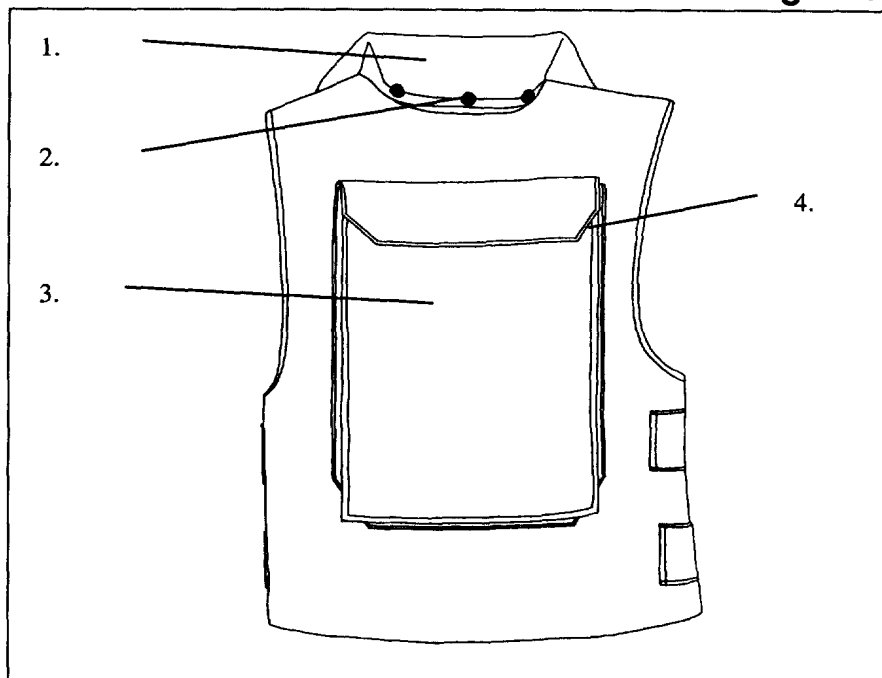
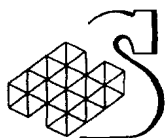


Figure 6: Vest C (Back View)

FEATURES	
1.	Collar
2.	Collar Snaps (Rear)
3.	Rear Plate Pocket
4.	Rear Plate Pocket Velcro



Annex A: Fragmentation Vests

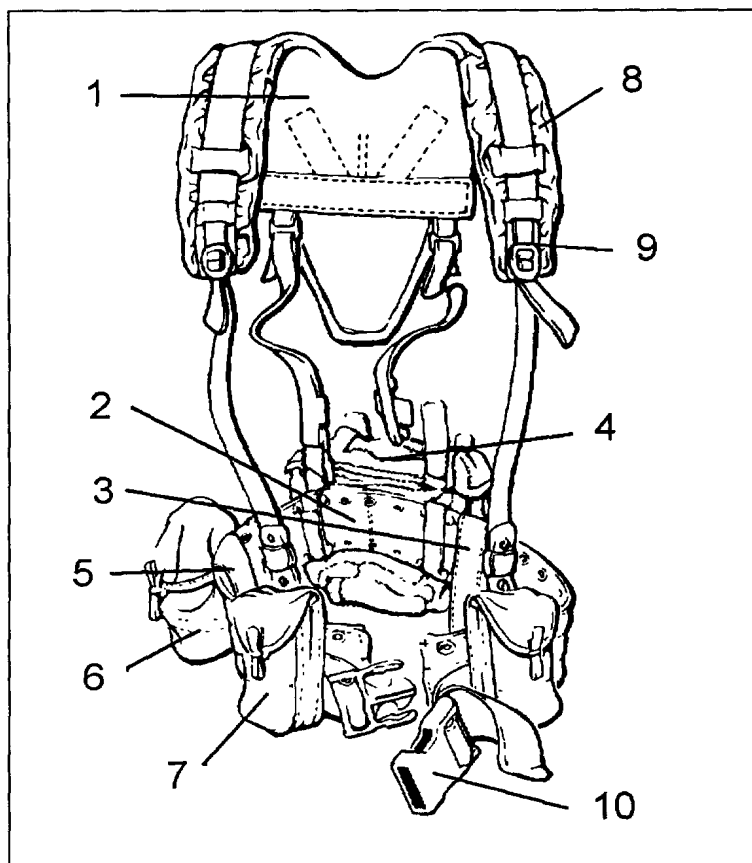
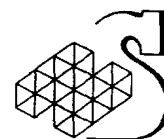


Figure 7: 1982- Pattern Webbing

FEATURES

- | |
|---------------------|
| 1. Yoke Straps |
| 2. Utility Belt |
| 3. Bayonet Holder |
| 4. Small Field Pack |
| 5. KFS Carrier |
| 6. Canteen Carrier |
| 7. Magazine Pouch |
| 8. Shoulder Straps |
| 9. Strap Adjusters |
| 10. Belt Connector |



Annex A: Fragmentation Vests

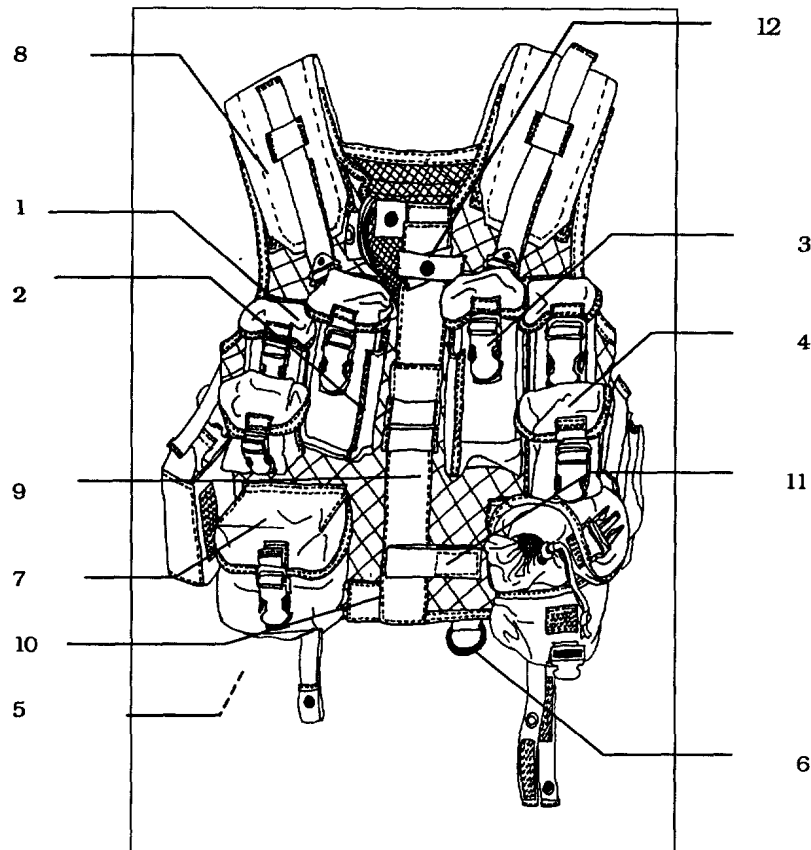
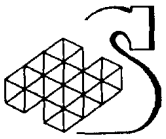


Figure 8: TAV Features -Front

FRONT FEATURES	
1. C7 Magazine Pocket	8. Auxiliary Pocket
2. Maglight/Pen Pocket	9. Shoulder Strap
3. Fastex Buckle	10. Front Flap
4. HE Grenade Pocket	11. Front Zipper
5. Smoke Grenade Pocket (Not Shown)	12. Velcro Tab
6. Fastex Belt Connector	13. Bayonet Frog
7. "D" Ring Attachment	



Annex A: Fragmentation Vests

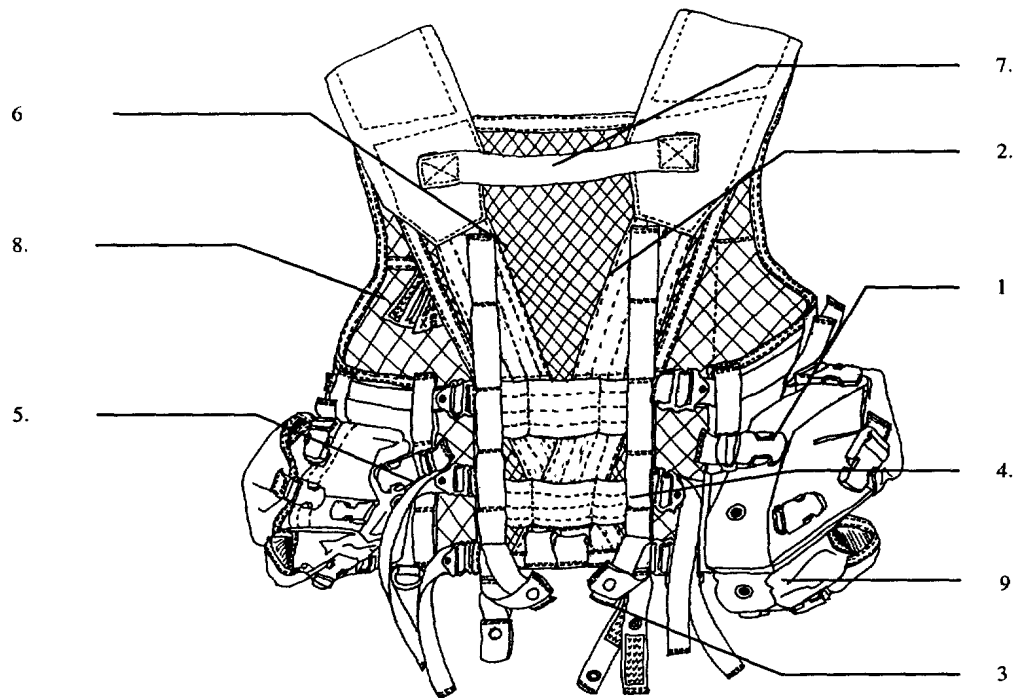
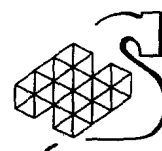


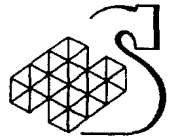
Figure 9: TAV Features -Back

BACK FEATURES	
1.	C9 Drum/Canteen Pocket
2.	Daisy-Chain webbing
3.	Webbing Belt Hanger
4.	Fit Adjustment Strap
5.	Fit Adjustment Buckle
6.	Mesh Fabric
7.	Casualty Extraction Strap
8.	Map Pocket
9.	Smoke Grenade Pocket



Annex B:
Participant Characteristics

ANNEX B:
Participant Characteristics



Annex B: Participant Characteristics

1. Introduction

Twenty-four male and female soldiers from across Canada comprised the trial participants. The participants included eight female soldiers and 16 male soldiers. The subjects were organized into three sections.

2. Method

Participants were measured to determine their anthropometric characteristics. Additionally, each participant completed a personal history form to describe their operational experience and assigned trade.

Each subject was measured to determine the following:

- Weight (kg)
- Stature (cm)
- Acromial Ht (cm)
- Suprasternale Ht (cm)
- Iliocristale Ht (cm)
- Shoulder circumference (cm)
- Chest circumference -(at the bust point) (cm)
- *Chest circumference below breast (cm) (n= 8 ♀)
- Waist circumference (cm)
- Neck circumference (cm)
- Hip circumference (cm)
- Torso length (cm)

* Only females were measured for chest circumference below the breast. The difference between chest circumference at the bust point and chest circumference below the breast is an indication of cup size.

Measurement procedures followed the DCIEM 1997 Land Force Anthropometric Survey protocol.



Annex B: Participant Characteristics

3. Results

3.1. General

The trial participants included the following:

	Combat Arms	Non-Combat Arms	Total
Males ♂	50% (12)	17% (4)	67% (16)
Females ♀	4% (1)	29% (7)	33% (8)
Total	54% (13)	46% (11)	100% (24)

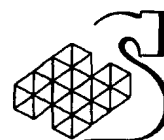
The trial participants had participated in a total of 24 United Nations or Peace Keeping operational missions. Additionally, 19 subjects had worn fragmentation vests on duty for periods of time.

One male subject was lost due to a non-trial related injury.

3.2. Anthropometry

The trial participants' anthropometric measurements were compared to the 1997 DCIEM Land Forces Anthropometric Survey (Table 1 and Figure 1 below) to determine whether the trial participants were representative of the general Land Force. Mean and standard deviation data are provided as well.

Except for Neck Circumference and Chest Circumference differences the trial subjects were representative of the Land Force. The trial subjects had significantly ($p < 0.05$) smaller Neck Circumferences and Chest Circumference differences ($p < 0.09$) than the Land Force Survey personnel.



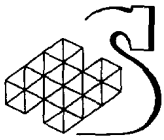
Annex B: Participant Characteristics

Anthropometric Measures	Trial Subjects (n=24)		CF 1997 Land Force Survey	
	Mean	S.D.	Mean	S.D.
Weight (kg)	76.1	14.8	77.0	14.1
Stature (cm)	169.0	8.6	171.4	8.4
Acromial Ht (cm)	138.7	6.8	140.2	7.3
Suprasternale Ht (cm)	138.0	7.1	139.5	7.2
Iliocristale Ht (cm)	103.1	6.0	103.7	5.7
Shoulder circumference (cm)	116.2	11.4	115.0	9.2
Chest circumference (cm)	91.8	11.1	95.2	9.4
*Chest circumference below breast (cm) (n=8)	80.3	9.4	81.4	7.3
Difference in chest circumference and chest circumference below the breast (cm) (n=8)	11.5	2.3	13.8	3.8
Waist circumference (cm)	86.6	10.7	90.4	11.6
Neck circumference (cm)	35.3	3.8	37.4	3.9
Hip circumference (cm)	102.0	7.3	101.4	7.5
Torso length (cm)	35.6	1.8	36.5	3.0

Key:  Significantly Smaller than the Land Force Survey Personnel ($p < 0.05$)

Table 2: Trial Sample and CF 1997 Land Force Survey Comparison

Cup size is directly related to the differences between chest circumference at the nipple and chest circumference below the breast. The female participants in the trial on average required a complete cup size smaller for brassieres than the average female in the CF 1997 Land Force Survey.



Annex B: Participant Characteristics

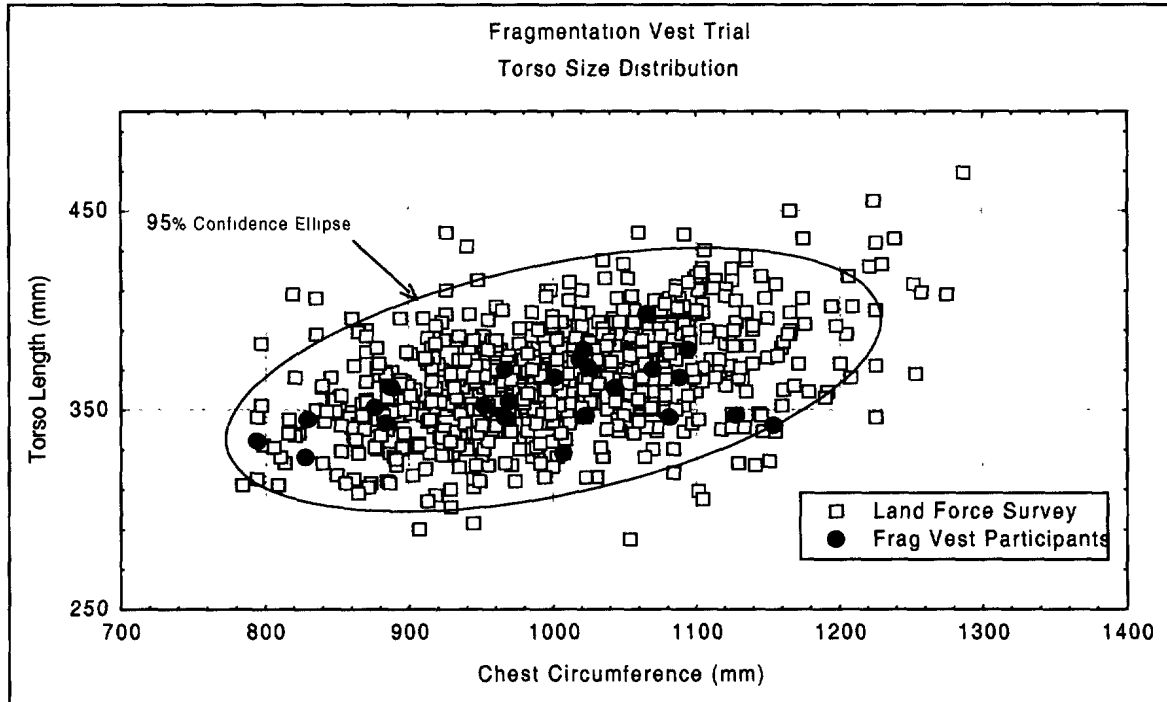


Figure 1: Bivariate Plot of Trial Participants and 1997 Land Force Survey Participants for Torso Length and Chest Circumferences.

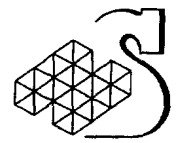
These results suggest that while there was generally a good representative range of body lengths and circumferences amongst trial participants, females with small cup sizes were over represented.

4. Discussion

It should be noted that the participants of the MOAT trial were first screened to assign subjects to either the Rucksack Trial or the Fragmentation Vest Trial. Since the Rucksack Trial was confirmatory in nature, subjects were preferentially chosen to provide a wide range of torso sizes. As a result, subjects with larger torso lengths were unavailable for the fragmentation vest trial. Additionally, the trial fragmentation vests were produced in a regular length only and thus short and long torsos could not be fitted properly.

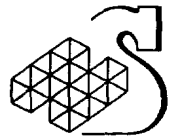
The results indicate that the trial sample was generally similar in distribution to the 1997 DCIEM LF Survey population. However, neck circumference and female cup sizes (difference between circumference at the nipple and below the breast) were significantly smaller than the general Land Force population suggesting that soldiers with larger neck and females bust sizes may not have been adequately represented in this trial.

A supplemental analysis of the female anthropometric data confirmed that the trial female subjects were significantly different than the females measured in the DCIEM 1997 LF Survey. The female subjects had smaller cup sizes on average than the normal CF female population. Thus, caution should be applied should be used before inferring any results to the general Land Force female population.



**Annex C:
Fit and Adjustment**

**ANNEX C:
Fit and Adjustment**



Annex C: Fit and Adjustability

1. Introduction

Fragmentation Vest fit and ease of adjustment were evaluated during the sizing and vest issue at the beginning of the trial.

2. Method

Participants were first selected based upon torso length sizing criteria (i.e., acromion height - iliac crest height). Subjects with very short or very long torso lengths were selected for the parallel rucksack trial. After screening, subjects were preliminarily assigned vests according to chest circumference. After initial vest assignment all the fitting and adjustment features to the three vests and TAV systems were demonstrated to the subjects. After the briefing subjects were given time to become familiar with the fragmentation vests and TAVs.

Participants then performed all necessary fitting adjustments, and practiced accessing vest soft and hard armour. If necessary, subjects were assigned to a more acceptable fitting vest. Participants then completed an initial fit and adjustability questionnaire and were measured to determine vest coverage.

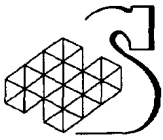
3. Results

3.1. General

Mean ratings for the fit and adjustment of the three vests are indicated in Figure 1. Statistically significant differences at ($p < 0.05$) are indicated. Overall, the subjects received an acceptable fit with all three vests – *Barely to Reasonably Acceptable*. The individual results for each vest are described below.

Vest A: Overall, the participants rated the fit and adjustability of Vest A as being *Barely to Reasonably Acceptable*. Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for vest length, shoulder girth, chest girth, neck opening, collar height, and shoulder pad fit. Vest A was also rated significantly ($p < 0.05$) more acceptable than Vest B for all adjustability questions, ease of donning and doffing and for overall fit. Vest A was rated significantly ($p < 0.05$) more acceptable than Vest C for rear plate pocket fit and ease of doffing.

Vest B: Overall, the participants rated the fit and adjustability of Vest B as being *Borderline to Barely Acceptable*. Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for vest length, shoulder girth, chest girth, neck opening, collar height, and shoulder pad fit. Vest B was also rated significantly ($p < 0.05$) less acceptable than Vest B for all adjustability questions, ease of donning and doffing and for overall fit. Vest B was rated significantly ($p < 0.05$) more acceptable than Vest C for rear plate pocket fit. Participants did not like the collar design of Vest B or its means of donning (one shoulder opening only).



Annex C: Fit and Adjustment

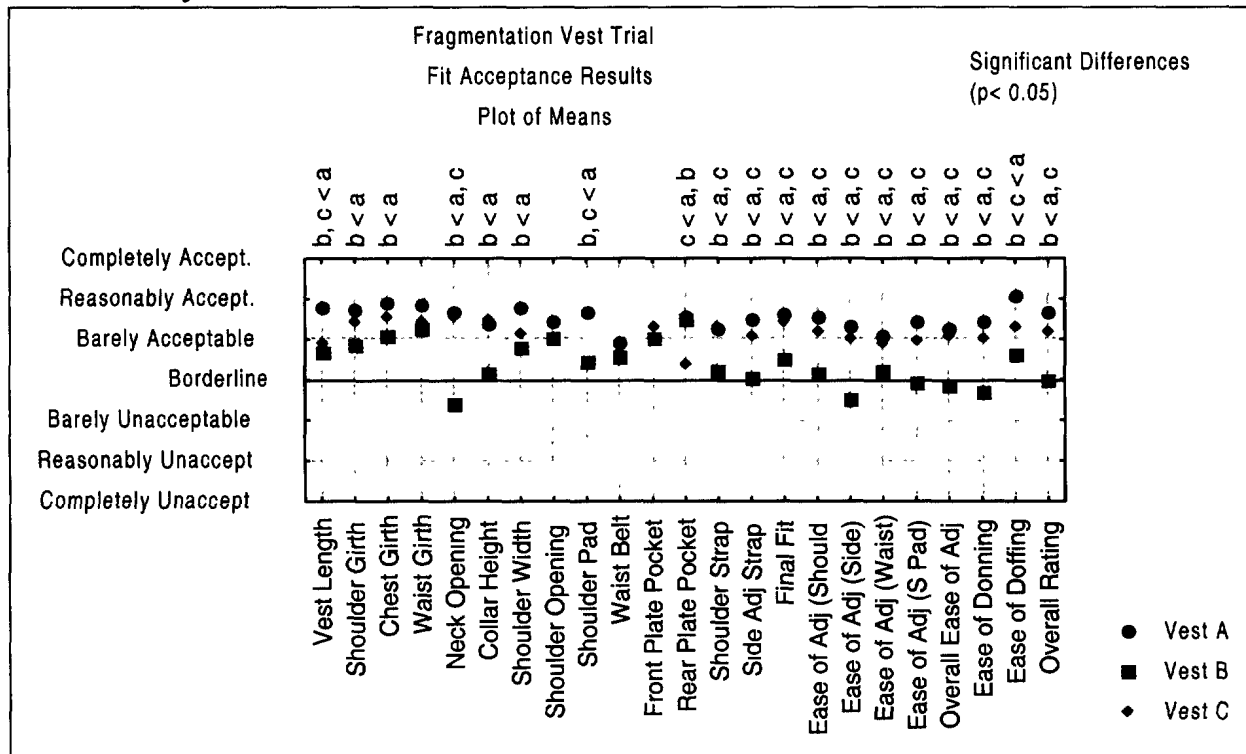
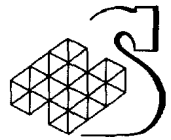


Figure 1: Fit and Adjustability Ratings

Vest C: Overall, the participants rated the fit and adjustability of Vest C as being *Barely Acceptable*. Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A shoulder pad fit. Vest C was also rated significantly ($p < 0.05$) more acceptable than Vest B for all adjustability questions, ease of donning and doffing and for overall fit. Vest C was rated significantly ($p < 0.05$) less acceptable than Vests A and B for rear plate pocket fit and Vest A for ease of doffing. The rear plate pocket on Vest C was designed to hold the CF back plate, but only front plates were utilized in the trial for both front and back plate pockets. Since the widths of the CF front and rear plates are different, Vest C could not accommodate a front plate in its rear pocket. Thus, participants rated the rear plate pocket fit as being unacceptable. Additionally subjects rated the ease of doffing as being significantly less acceptable than Vests A and B. This was due to the double locking velcro shoulder strap which required more effort to undo as compared to Vest A and C.

3.2. Fit Achievement

As part of the fit and adjustability questionnaire, participants rated the fit acceptance (i.e. too large, long or loose, versus too short, small or tight) for vest features. Except for the fit of Vest C's rear plate pocket, participants rated the fit of all vests as being *good to borderline*. The results of the fit acceptance are detailed below in Figure 2.



Annex C: Fit and Adjustability

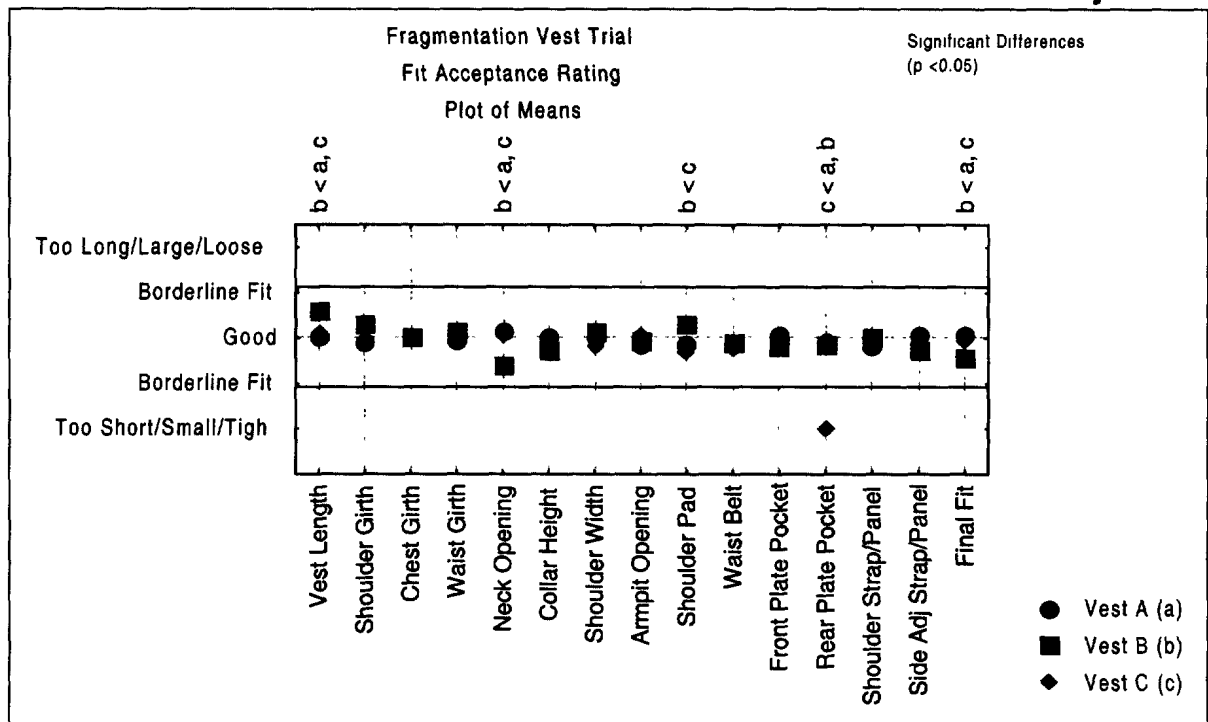


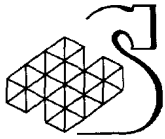
Figure 2: Fit Acceptance Rating

A statistical analysis of the non-parametric fit acceptance results using the Mann Whitney U Test indicated that the significantly less acceptable fit of Vest B may be attributed to its poorer fit acceptance ratings for vest length, neck opening and shoulder pad ratings. Participants did achieve an acceptable fit with each of the three vest conditions.

3.3. Gender Effect

Mean ratings for the fit and adjustment of the three vests by gender are indicated in Figure 3. Overall, the male and female subjects received an acceptable fit with all three vests *Barely to Reasonably Acceptable*.

A post-hoc analysis indicated that the females rated Vest A significantly more acceptable than their male counterparts. Both males and females rated Vest A as being significantly ($p < 0.05$) more acceptable than Vest B for Fit and Adjustability. Additionally, the females rated Vest C as being significantly ($p < 0.05$) more acceptable than Vest B for Fit and Adjustability.



Annex C: Fit and Adjustment

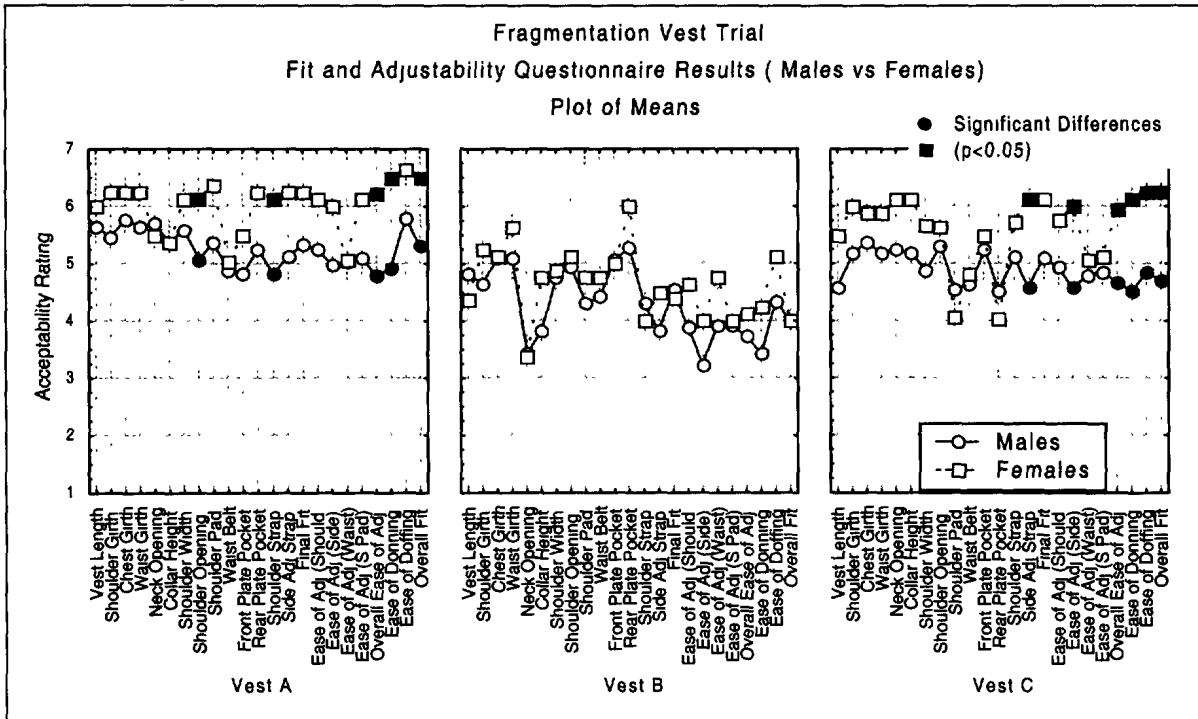


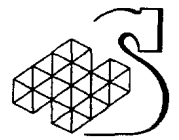
Figure 3: Fit and Adjustability Results According to Gender

4. Discussion

Overall, the male and female participants achieved an acceptable fit with each of the three vest conditions. The participants did rate Vest A and C significantly ($p < 0.05$) more acceptable than Vest B for overall fit and adjustability.

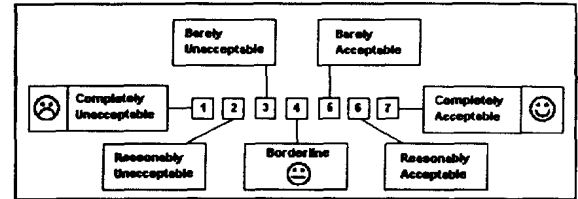
The design and means of access affected the subject's rating of their perceived fit with Vest B. Subjects rated the high collar of Vest B as being unacceptable. Additionally the subjects did not like the one shoulder adjustment style associated with Vest B.

Although limited vest sizes was worrisome at the beginning of the trial, the results indicate that all the subjects achieved an acceptable fit. Thus, poor vest fit did not confound the results of the remainder of the trial.



**Appendix 1 to Annex C:
Fit and Adjustability**

**APPENDIX 1 TO ANNEX C:
Fit and Adjustability Questionnaire**

**PERSONAL DATA**

Clearly indicate your Name, Subject Number and Fragmentation Vest Type.

NAME

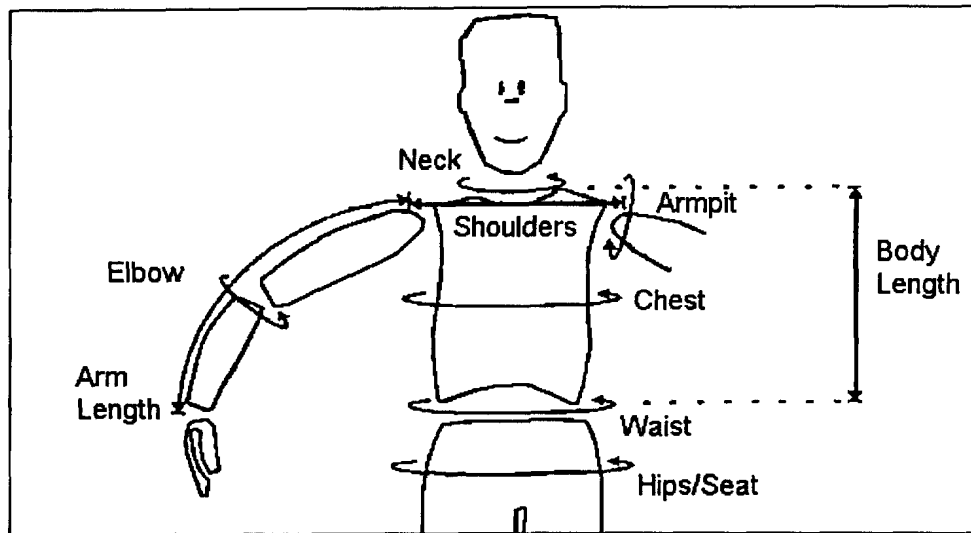
SUBJECT NUMBER

FRAGMENTATION VEST TYPE

Vest A: ☐Vest B: ☐Vest C: ☐

Rate the following Features	Fit Acceptance Rating							Fit Sizing				
	1	2	3	4	5	6	7	Short Small Tight			Long Large Loose	
Vest Length*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder Girth*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Chest Girth*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Waist Girth*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Neck Opening*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Collar Height	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder Width	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder Opening*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder Pad	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Waist Belt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Front Plate Pocket	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Rear Plate Pocket	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

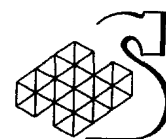
* See Figure on Next Page



Rate the following Features	User Acceptance Rating							Fit Acceptance Rating				
	1	2	3	4	5	6	7	Short/Small/Tight				Long/Large/Loose
Shoulder Strap/Panel	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Side Adj Strap/Panel	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Final Fit	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ease of Adjustments (Shoulder Straps/Panel)	☐	☐	☐	☐	☐	☐	☐					
Ease of Adjustments (Side Straps/Panel)	☐	☐	☐	☐	☐	☐	☐					
Ease of Adjustments (Waist Belt)	☐	☐	☐	☐	☐	☐	☐					
Ease of Adjustments (Shoulder Pad)	☐	☐	☐	☐	☐	☐	☐					
Overall Ease of Adjustment	☐	☐	☐	☐	☐	☐	☐					
Ease of Donning	☐	☐	☐	☐	☐	☐	☐					
Ease of Doffing	☐	☐	☐	☐	☐	☐	☐					
Overall Rating for Fitting	☐	☐	☐	☐	☐	☐	☐					



ADDITIONAL COMMENTS:



**Annex D:
Coverage**

ANNEX D

Coverage

1. Introduction

Vest coverage and coverage acceptability was evaluated at the beginning of the trial.

2. Method

With the vest adjusted and fitted to the participants, the limits of soft and hard armour coverage were measured. First, the limits of soft armour coverage were determined by measuring the height of the soft armour hem relative to the iliacristale height, the height of the front of the neck opening relative to the sternal notch, and length of shoulder coverage from the acromium. Hard armour coverage was then determined by measuring the top of both the front and back hard armour plates in relation to the sternal notch. – see Figure 1.

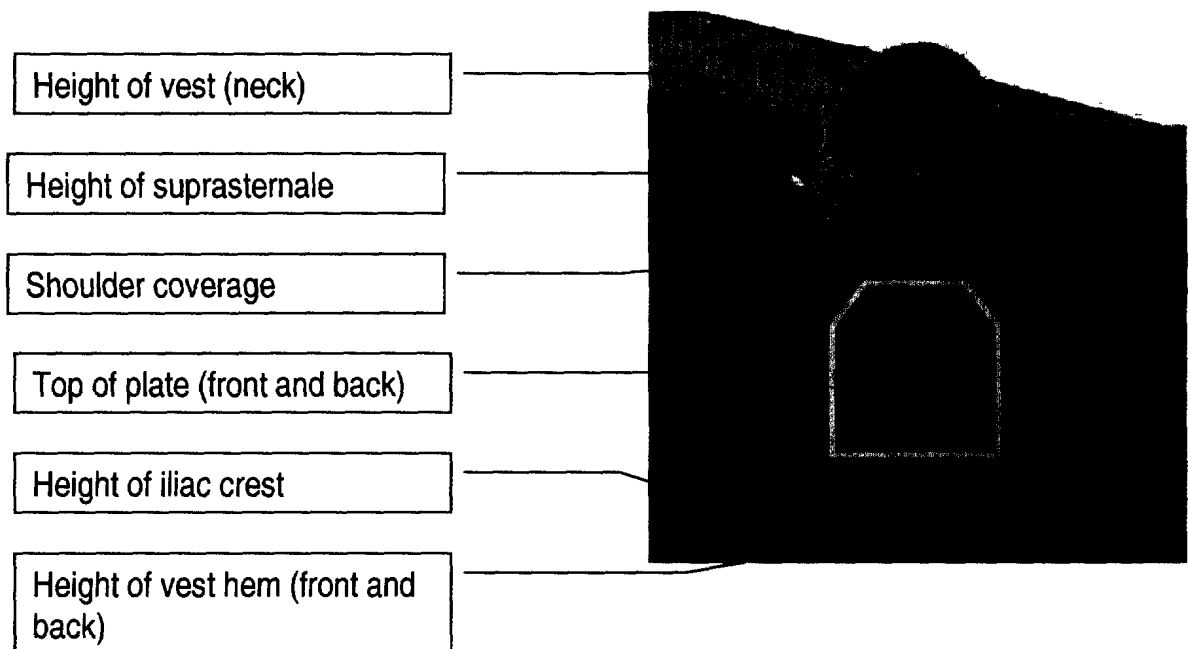
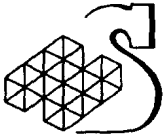


Figure 1: Measurement Sites

After being measured, participants completed a coverage acceptability questionnaire.



Annex D: Coverage

3. Results

3.1. General

Mean ratings and standard deviations for the coverage provided by the three vests are indicated in Table 1. Statistically significant differences at ($p < 0.05$) are indicated. The coverage provided by the three vest types was distinctly different. Overall, Vest B provided the most coverage, while Vest C provided the least coverage.

		Vest A		Vest B		Vest C	
		Mean (cm)	sd (cm)	Mean (cm)	sd (cm)	Mean (cm)	sd (cm)
1.	Ht of front hem	94.8	6.8	92.3	6.2	96.4	6.3
2.	Ht of rear hem	95.6	6.4	93.8	6.4	97.4	5.7
3.	Ht of neck opening (lowest point of coverage)	136.1	7.5	142.7	7.4	135.7	7.6
4.	Ht of front plate top	130.2	8.7	135.5	7.6	131.3	8.9
4a.	Difference front plate to suprasternale	7.9	2.8	2.6	1.7	6.4	2.9
5.	Ht of rear plate top	134.3	8.7	138.6	8.1	NA	NA
5a.	Difference rear plate to suprasternale	3.7	1.8	-0.7	2.2	NA	NA
6.	Length of shoulder coverage	22.0	1.4	26.9	0.6	12.5	0.6

Key: Statistically significant coverage differences at $p < 0.05$



Most Coverage



Middle Level Coverage



Least Coverage

Table 1: Coverage Measurement Results

Vest A: Vest A was significantly shorter than Vest B by an average of 1.5 cm, but was longer than Vest C by 2.5 cm. Vest A also had a significantly lower neck opening than Vest B, as well as shorter shoulder pad coverage. Vest A was a compromise in coverage between Vests B and C. While the height of the front plate was significantly lower than Vest B, Vest A's design has a height adjust feature to raise the plate height as required. Participants tried to adjust their front plate heights prior to measuring, but the front plate was positioned too low.

Vest B: As expected, Vest B provided the most coverage. It provided significantly ($p < 0.05$) more coverage than Vests A and C for vest length, neck coverage and shoulder coverage. The top of Vest B's front plate is at the recommended height (2.5 cm below suprasternale), where it provides coverage of the aortic arch. Vest B's rear plate was mounted approximately 3.2 cm above the optimum height.

Vest C: Vest C was significantly shorter than Vest B by an average of 4.1 cm, and Vest A by 1.5 cm. Vest C also had a significantly lower neck opening and than Vest B, as well as shorter shoulder pad coverage than Vest A or B. Vest C provided the least coverage of the three vests. While the height of the front plate was significantly lower than Vest B, Vest C's design has a height adjust feature to raise the plate height as required. Participants tried to adjust their front plate heights prior to measuring, but the front plate was positioned too low. As mentioned earlier participants could not mount the rear plate into its pocket.

3.2. Coverage Acceptance Questionnaire Results

In addition to the physical measures, participants also completed a coverage acceptability questionnaire. While the coverage provided by all three vest conditions was rated as being acceptable, the participants believed the coverage provided by Vest B bordered on too much and that Vest C bordered on too little coverage – see Figure 2.

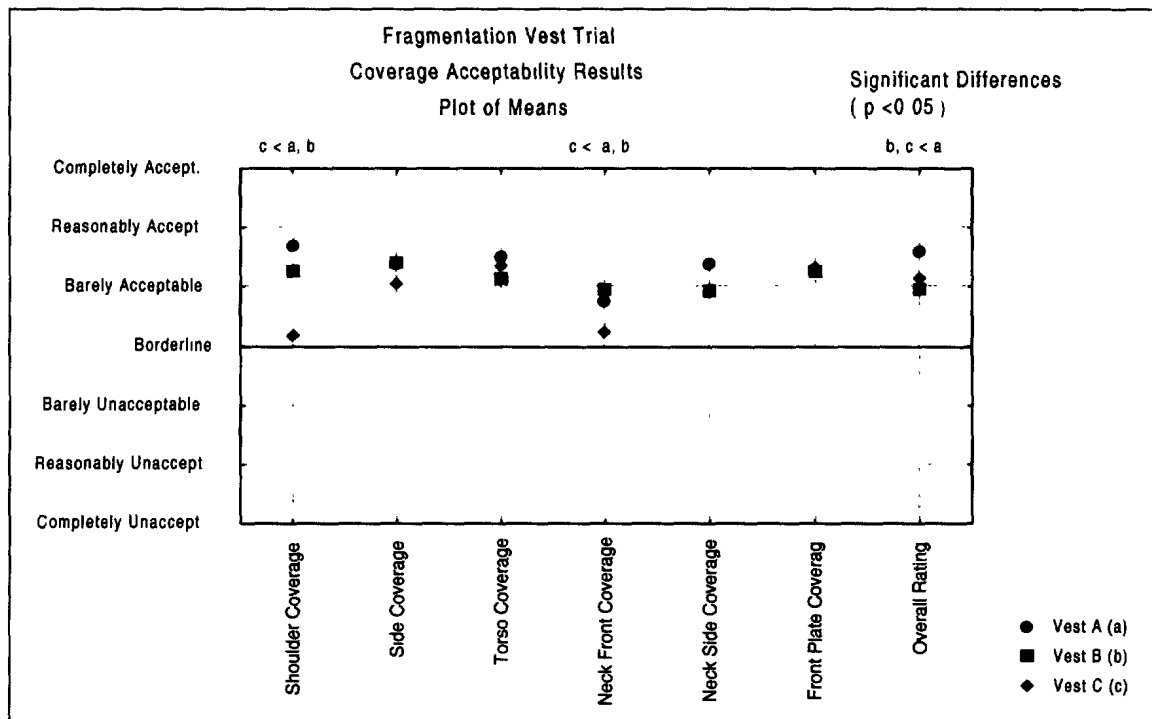
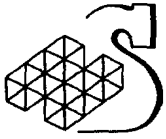


Figure 2: Fragmentation Vest Coverage Acceptability Results

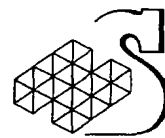


Annex D: Coverage

The coverage provided by Vest C was significantly ($p < 0.05$) less acceptable than the coverage provided by Vest B in the shoulder and neck areas. Overall the coverage provided by Vest A was significantly ($p < 0.05$) more acceptable than the minimum coverage provided by Vest C or the maximum provided by Vest B.

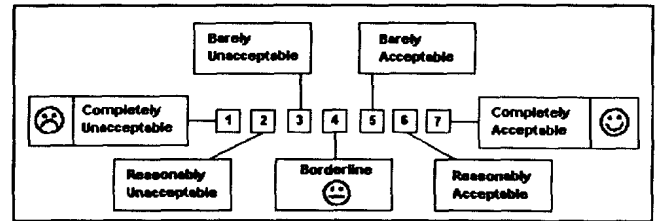
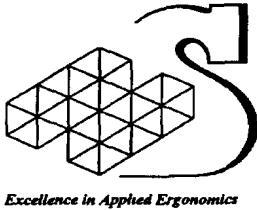
4. Discussion

Participants believed that the coverage provided by Vest C was too little, while the coverage provided by Vest B was too much. Participants commented that Vest B limited their freedom of movement, some to the point where they referred to it as a straight jacket. The extra coverage provided by Vest B at the neck and shoulders caused physical discomfort. Overall, the participants found that Vest A was a good compromise between the two extremes.



**Appendix 1 to Annex D:
Coverage**

**APPENDIX 1 TO ANNEX D:
Coverage Questionnaire**

**PERSONAL DATA**

Clearly indicate your Name, Subject Number and Fragmentation Vest Type.

NAME

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SUBJECT NUMBER

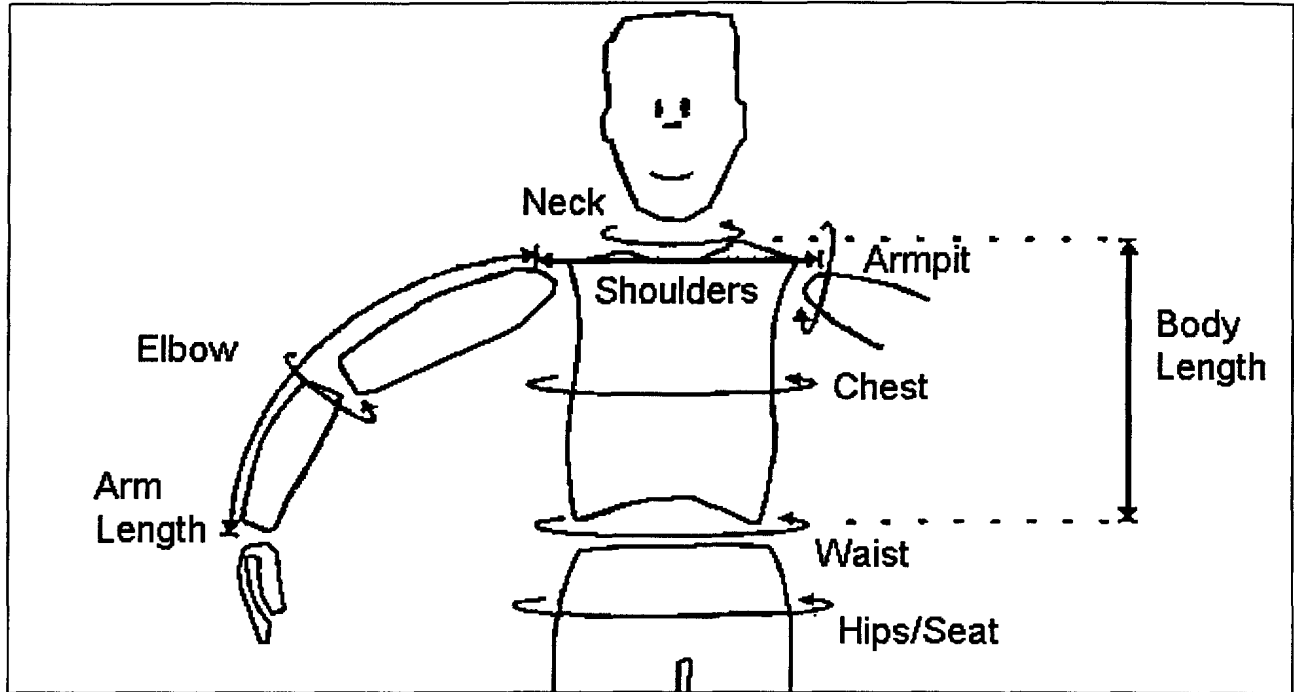
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FRAGMENTATION VEST TYPE

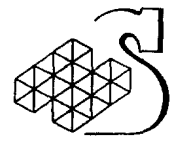
Vest A: ☐Vest B: ☐Vest C: ☐

Please Rate the Level of Protective Coverage	User Acceptance Rating							Comments
	1	2	3	4	5	6	7	
Shoulder Coverage*	☐	☐	☐	☐	☐	☐	☐	
Side Coverage*	☐	☐	☐	☐	☐	☐	☐	
Torso Coverage*	☐	☐	☐	☐	☐	☐	☐	
Front of Neck Coverage*	☐	☐	☐	☐	☐	☐	☐	
Sides of Neck Coverage*	☐	☐	☐	☐	☐	☐	☐	
Front Plate Coverage	☐	☐	☐	☐	☐	☐	☐	
Rear Plate Coverage	☐	☐	☐	☐	☐	☐	☐	
Overall Rating for Coverage	☐	☐	☐	☐	☐	☐	☐	

* See Figure on Next Page



ADDITIONAL COMMENTS:



**Annex E:
Accessibility**

**ANNEX E:
Accessibility**

1. Introduction

The ease and reliability of replacing the internal soft armour panels and auxiliary hard armour strike plates was evaluated for each vest design.

2. Method

Participants were required to remove completely and re-insert both the hard and soft armour components. The soft armour components included front and back panels, shoulder pad panels and neck panels if appropriate. HF observers evaluated the ease of accessibility and noted any installation errors. Particular attention was paid to ensure that panels were reinserted properly and that ballistic coverage integrity was maintained.

3. Results

3.1. Soft Armour Replacement

The participants rated the ease and reliability of soft armour replacement as being acceptable for all vest conditions – see Figure 1. No significant accessibility or reliability differences were identified between the three vest conditions. The ratings were barely acceptable due to it being awkward to make the insert ballistic panel locating velcro match with the corresponding carrier locating velcro inside.

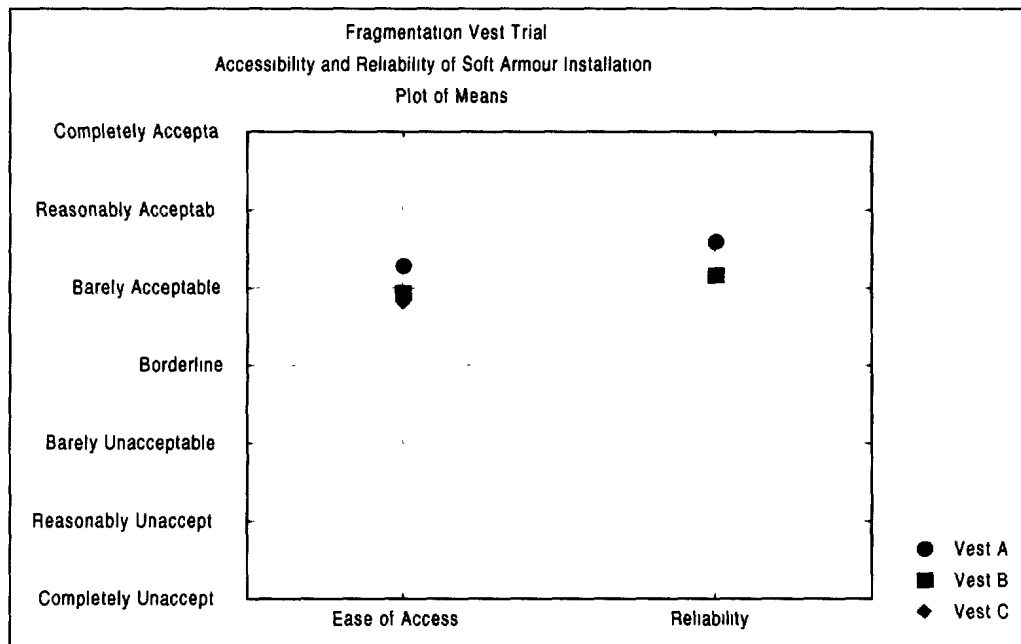
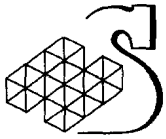


Figure 1: Acceptability Rating of Soft Armour Replacement.



Annex E: Accessibility

3.2. Hard Armour Replacement

The participants rated the ease and reliability of hard armour replacement as being acceptable for all vests conditions – see Figure 2. No significant accessibility or reliability differences were identified between the three vest conditions. The ratings for Vest C include the front plate only.

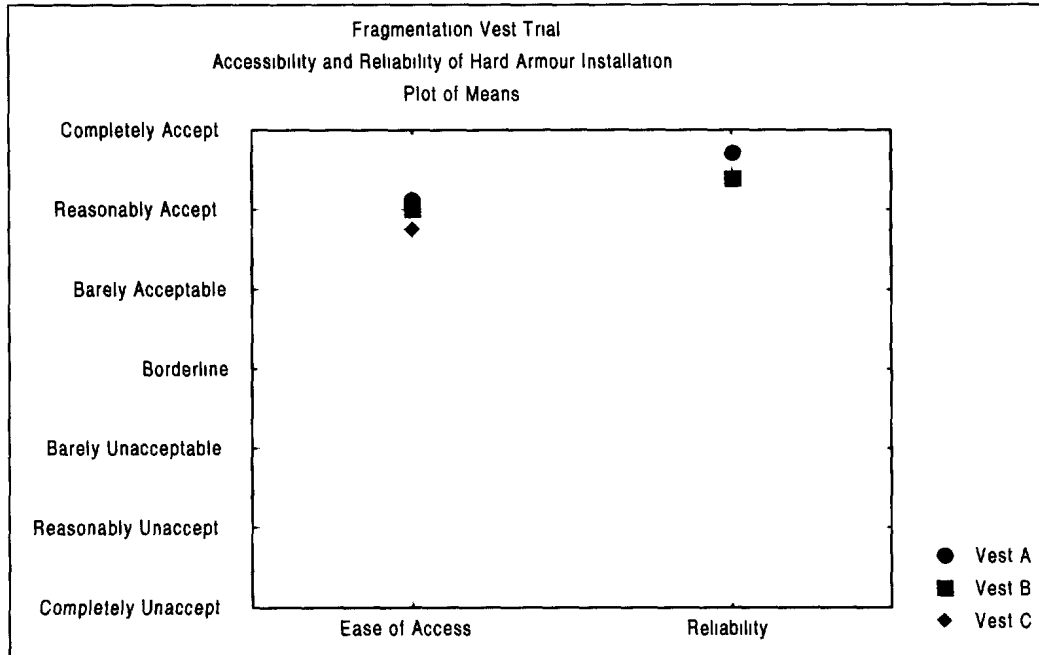
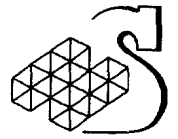


Figure 2: Acceptability Rating of Hard Armour Replacement.

4. Discussion

There were no significant differences between vests for soft or hard armour replacement. Although replacement of the soft armour panels could be tricky, all the participants rated the ease of replacement as being *Barely to Reasonably Acceptable*. Thus, cleaning, maintenance and replacement of vest shells by the users should not be problematic.



**Annex F:
Range of Motion**

**ANNEX F:
Range of Motion**



Annex F: Range of Motion

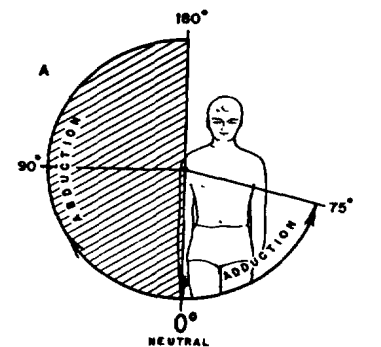
1. Introduction

The degree to which each vest restricted the wearer's range of motion was evaluated and compared to a baseline range without a vest.

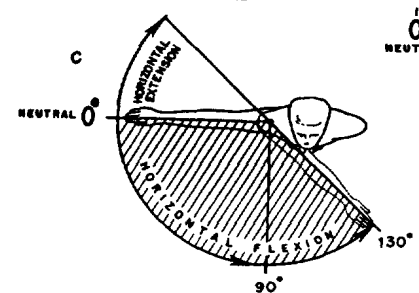
2. Method

Each participant donned and adjusted each fragmentation vest condition over their combat clothing. The following ranges of motion were then measured for all fragmentation vest designs worn without fighting order. All measures included a combat clothing baseline.

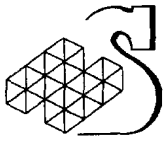
Shoulder Abduction: Standing with their backs to a wall, participants raised their straight right arm laterally in the frontal plane until they perceived resistance. The HF observer then measured the angle of the upper arm, relative to the vertical, at the point of resistance.



Medial Shoulder Flexion: Standing, bent forward at the waist with the back parallel to the floor, participants moved their straight right arm medially across their chest until they perceived resistance. The HF observer then measured the angle of the upper arm, relative to the horizontal, at the point of resistance.

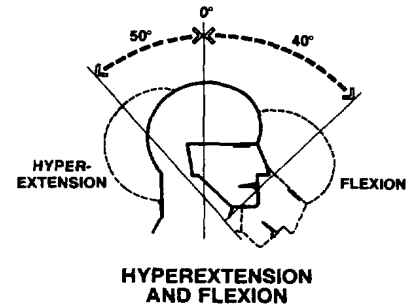


Sagittal Waist Flexion: Sitting on the floor with straight legs and their feet about 30 cm apart, participants bent forward at the waist while reaching forward along a measuring stick. The HF observer measured the sustained reach distance.



Annex F: Range of Motion

Sagittal Neck Extension: Standing upright with straight legs and their feet about 30 cm apart, participants extended their head and neck back until they perceived resistance. All participants wore their new Soldier's helmet for this test. The HF observer then measured the final neck extension angle and noted any helmet/fragmentation vest clash.



3. Results

Mean ratings and standard deviations for the range of motion provided by the three vests are indicated in Figures 4 to 7. Statistically significant differences ($p < 0.05$) are indicated for each movement.

3.1. Shoulder Abduction

The no vest condition provided the greatest shoulder abduction range of motion. The no-vest condition as well as Vest C allowed significantly ($p < 0.05$) greater range of motion than Vests A and B for shoulder abduction. Shoulder pads limited shoulder abduction.

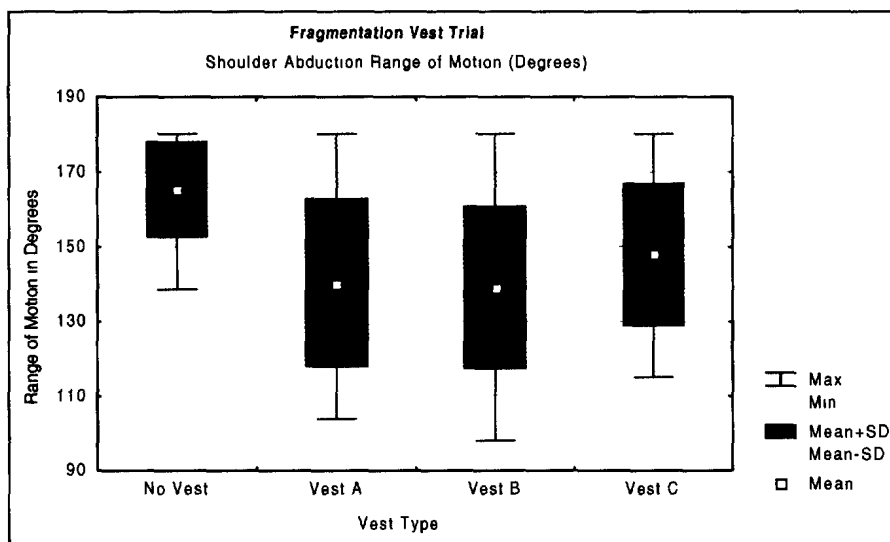
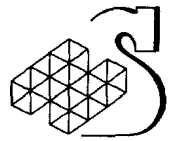


Figure 4: Shoulder Abduction Results

3.2. Medial Shoulder Flexion

The no-vest condition provided the greatest medial shoulder flexion. The no-vest condition allowed significantly ($p < 0.05$) greater medial shoulder flexion than Vests A, B and C. The no-vest condition did not have vest bulk limiting medial flexion.



Annex F: Range of Motion

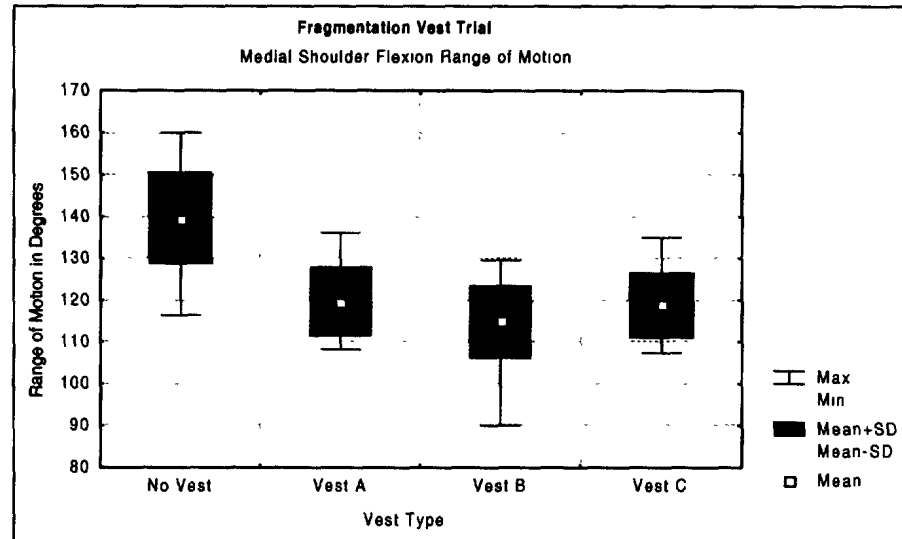


Figure 5: Medial Shoulder Flexion Results

3.3. Sagittal Waist Flexion

The no-vest condition provided the greatest waist sagittal range of motion. The no-vest condition provided significantly ($p < 0.05$) greater waist flexion range of motion than vest A, B or C. Vests A and C provided significantly ($p < 0.05$) greater waist flexion range of motion than Vest B. The shorter the vest, the higher the waist flexion. Vest B with the longer torso length had the lowest sagittal waist flexion.

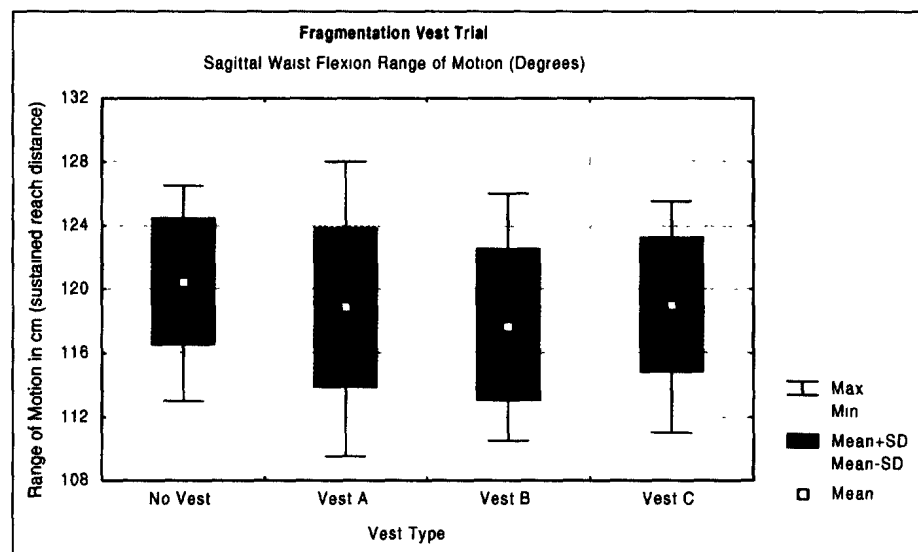
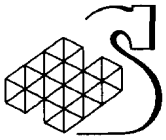


Figure 6: Waist Flexion Results



Annex F: Range of Motion

3.4. Neck Extension

The no-vest condition provided the greatest neck extension range of motion. The no-vest condition provided significantly ($p < 0.05$) greater neck extension range of motion than Vests A, B or C. Vests A and C provided significantly ($p < 0.05$) greater neck extension range of motion than Vest B. The shorter the collar, the higher the neck extension range of motion. Vest B with its high protective collar compromised neck range of motion.

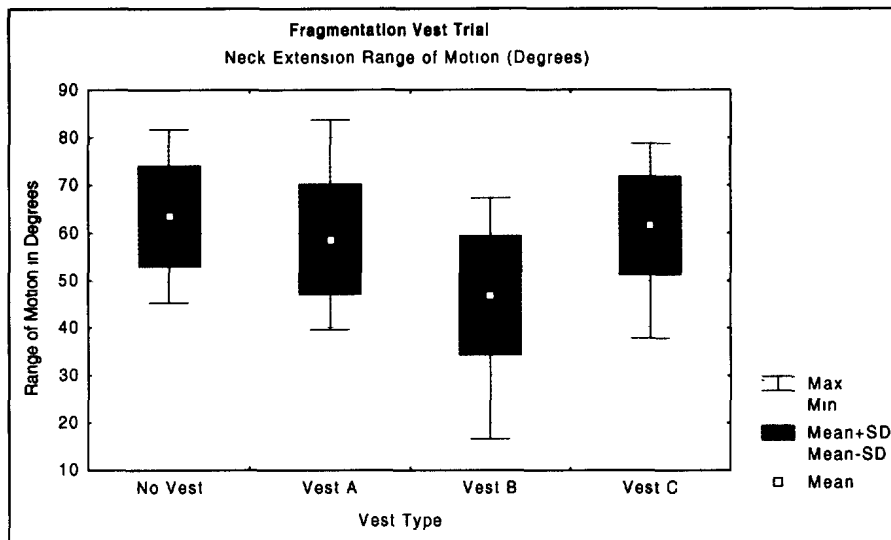
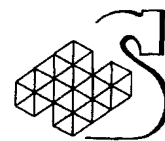


Figure 7: Neck Extension Results

4. Discussion

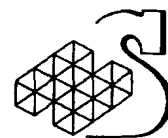
As expected the No Vest condition generally resulted in significantly greater ranges of motion than all other vest conditions for shoulder abduction, shoulder flexion, waist flexion and for neck extension. Vest B evidenced the poorest ranges of motion for shoulder abduction, shoulder flexion, waist flexion and for neck extension.

Wearing any fragmentation vest will reduce range of motion. Subjects commented that they preferred vest designs, which do not limit their range of motion, rather than vests that provide increased protection. Neck and shoulder pad design, torso length and arm opening greatly influence range of motion.



**Annex G:
Compatibility**

**ANNEX G:
Compatibility**



Annex G: Compatibility

1. Introduction

Participants were required to evaluate the compatibility of each vest condition with each of the following:

- C7A1
- C9 LMG
- Carl Gustav
- M72
- IECS Jacket and Parka
- Temperate Combat Gloves
- MLVW and Bison Vehicles

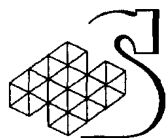
2. Method

Compatibility with personal & crew served weapons, clothing and equipment was assessed with each vest condition. Additionally, compatibility with selected weapons and clothing items was also assessed by participants wearing the vest conditions with plates.

Fragmentation vest/fighting order compatibility clash was identified and evaluated outdoors at four static test stands. Participants were divided into smaller groups to perform the required drills and HF observers collected compatibility measurement data and participant ratings. Participants were encouraged to adjust and configure their fragmentation vest and fighting order to the best of their ability to accommodate the test clothing and equipment prior to each test within the limits of providing proper protection. Each participant was evaluated separately under the close observation of the HF observer. All test stands were evaluated while wearing the new Soldier's helmet.

2.1. Weapons

Participants were required to rate the compatibility of each vest condition with the C7A1 rifle, C9 LMG, Carl Gustav and the M72 rocket launcher. Compatibility with the C7A1 and C9 LMG was also assessed with plates. Subjects were required to perform the relevant "tests on elementary training" (TOETs). Participants performed the TOETs on the C7A1 and C9 LMG in the prone position – see Figures 1 to 4.



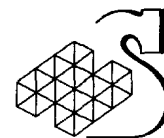
**Annex G:
Compatibility**



Figure 1: Participants Performing C7A1 Rifle TOETs



Figure 2: Participants Performing C9 LMG TOETs



Annex G: Compatibility



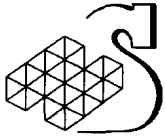
Figure 3: Participants Performing Carl Gustav TOETs



Figure 4: Participants Performing M72 TOETs

2.2. Clothing and Equipment

Participants were required to rate the compatibility of each vest condition with the IECS Jacket, IECS Parka, and temperate combat gloves. The compatibility of the fragmentation vests with the Clothe the Soldier (CTS) prototype rucksack and patrol pack was evaluated in the separate but concurrent Rucksack Field Trial. The compatibility of the fragmentation vests with the Clothe the Soldier (CTS) prototype combat gloves is reported in the concurrent Temperate Combat Glove Field Trial Report.



Annex G: Compatibility

2.3. Vehicles

Compatibility with the MLVW and Bison vehicles was assessed with each vest condition - see Figures 5 to 7. Compatibility with the MLVW was also assessed with participants wearing vests with plates. Compatibility of vests with plates was not assessed with the Bison because of its armoured construction.



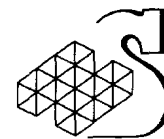
Figure 5: MLVW Compatibility Testing



Figure 6: Bison Vehicle Compatibility Testing



**Figure 7: Bison Compatibility Testing
(Ingress and Egress)**



Annex G: Compatibility

3. Results

3.1. Weapons

Participants were required to rate the compatibility of each vest condition with the C7A1 rifle, C9 LMG, Carl Gustav and the M72 rocket launcher. Compatibility with the C7A1 and C9 LMG was also assessed with plates –see Figures 1 and 2. Results for each vest and plate condition are described below. The C7A1 rifles were not available with modified butt lengths.

3.1.1. C7A1 Rifle Compatibility

Participants were required to rate the compatibility of each vest condition with the C7A1 rifle with and without plates. Results for each vest and plate condition are described below in Figures 8 and 9.

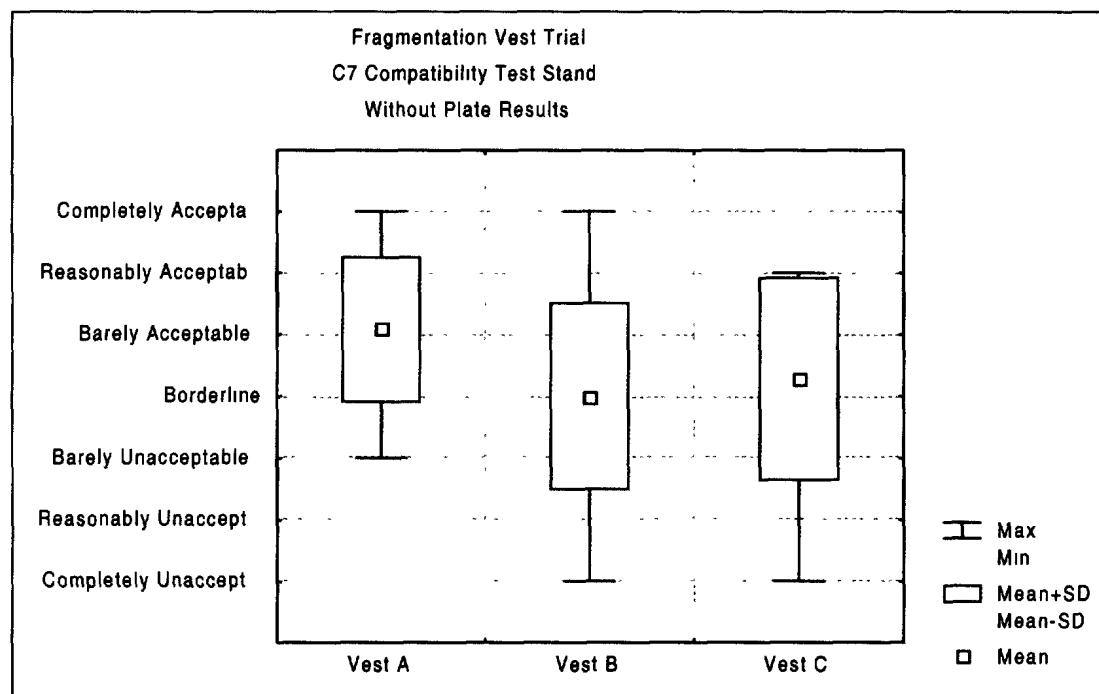
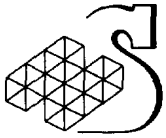


Figure 8: C7A1 Rifle Compatibility Results (Without Plates)



Annex G: Compatibility

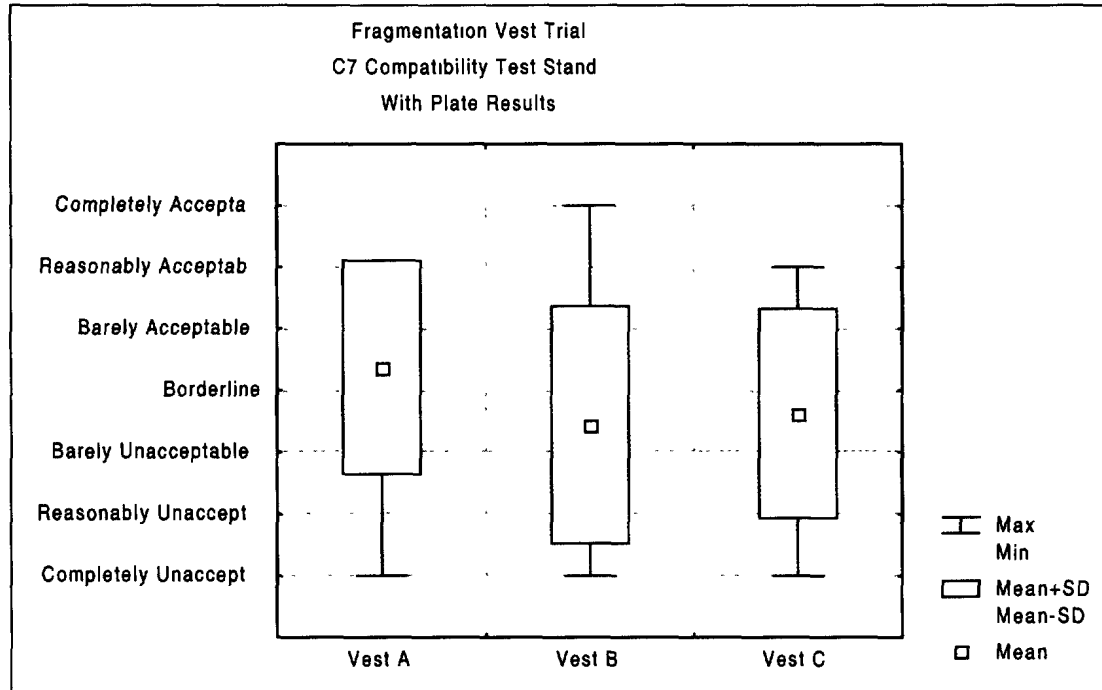
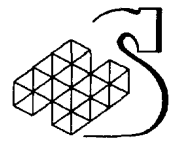


Figure 9: C7A1 Rifle Compatibility Results (With Plates)

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for C7A1 and C9 LMG compatibility without plates (*Barely to Reasonably Acceptable*). Vest A's compatibility with the C7A1 while wearing plates was rated as being acceptable (*Borderline to Barely Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for C7A1 and C9 LMG compatibility without plates (*Borderline*). Vest B's compatibility with the C7A1 while wearing plates was rated as being unacceptable (*Borderline to Barely Unacceptable*). The excess material in the length of Vest B caused material bunching at the waist and in the upper back of participants, especially in the prone position – see Figure 10. The cumbersome shoulder pads and elastic attachment strap also caused compatibility problems with Vest B.



Annex G: Compatibility

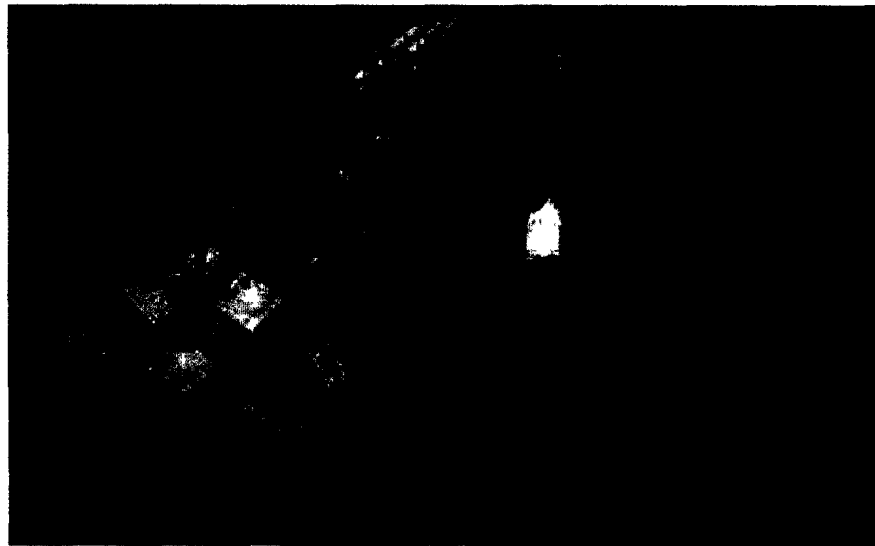
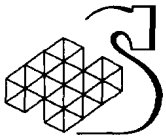


Figure 10: Vest B - Note the bunching at the shoulders and restriction of the shoulder pad.

Vest C: Vest C's compatibility with the C7A1 while not wearing plates was rated as being acceptable (*Borderline to Barely Acceptable*). Vest C's compatibility with the C7A1 while wearing plates was rated as being unacceptable (*Borderline to Barely Unacceptable*). Vest C suffered from shoulder and rifle butt slippage problems with the weapons evaluated. Additionally, weapon compatibility with Vest C while wearing plates was problematic due to plate interference and vest instability.

3.1.2. C9 LMG Compatibility

Participants were required to rate the compatibility of each vest condition with the C9 LMG, with and without plates. Results for each vest and plate condition are described below Figures 11 and 12.



Annex G: Compatibility

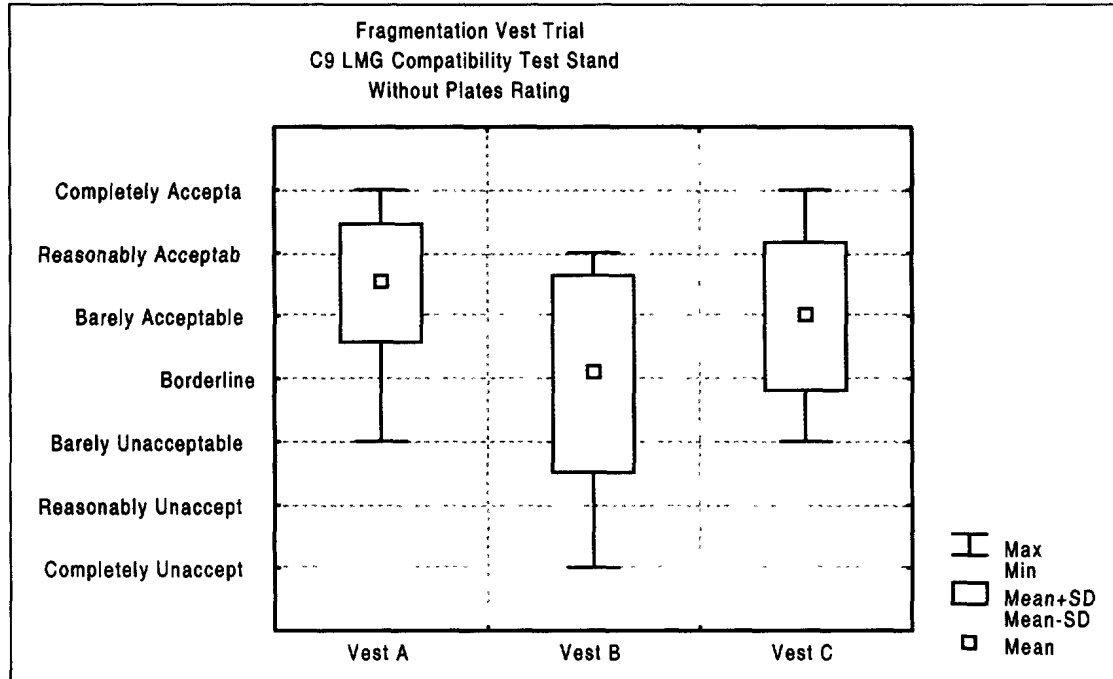


Figure 11: C9 LMG Compatibility Results (Without Plates)

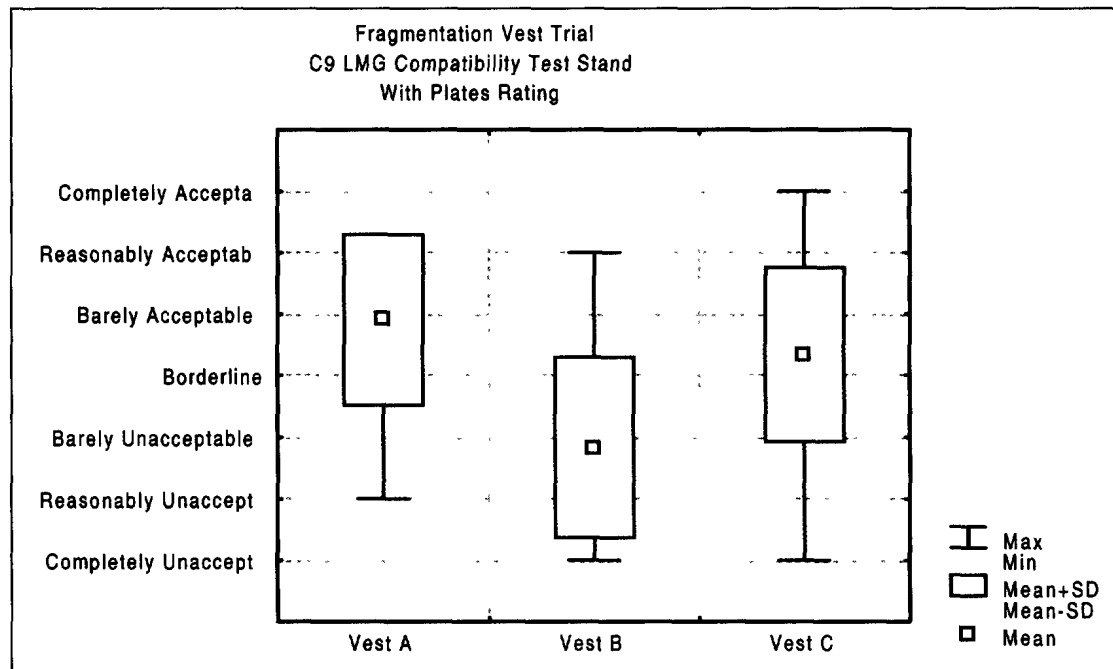
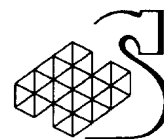


Figure 12: C9 LMG Compatibility Results (With Plates)



Annex G: Compatibility

Vest A: Vest A was rated as being significantly ($p < 0.05$) more acceptable than Vest B for C9 LMG compatibility while wearing plates (*Borderline to Barely Acceptable*).

Vest B: Vest B was rated as being significantly ($p < 0.05$) less acceptable than Vests A and C for C9 LMG compatibility while wearing plates (*Barely to Reasonably Unacceptable*). The excess material in the length of Vest B caused material bunching at the waist and in the upper back of participants, especially in the prone position- see Figure 13. The cumbersome shoulder pads and elastic attachment strap also caused compatibility problems with Vest B.

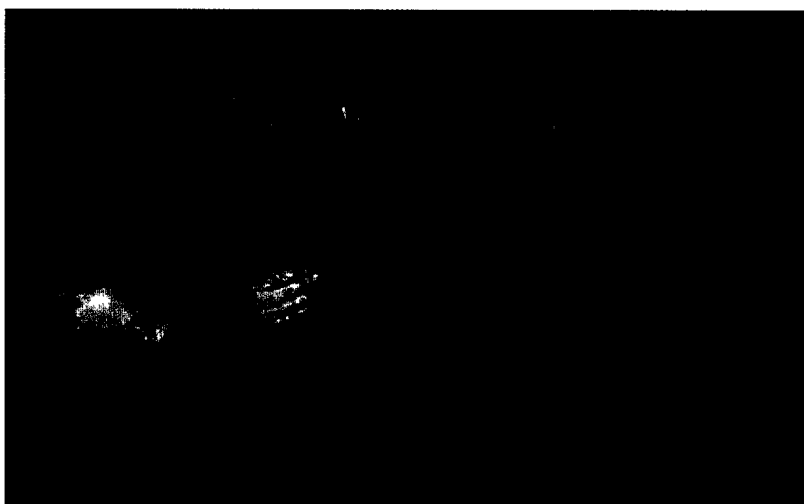
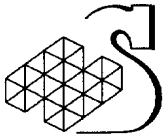


Figure 13: Vest B –Material Bunching with the C9 LMG

Vest C: Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for C9 LMG compatibility, with and without plates (*Borderline to Barely to Acceptable*). Vest C suffered from shoulder and butt slippage problems with the weapons evaluated. Additionally, weapon compatibility with Vest C while wearing plates was problematic due to plate interference and vest instability.

3.1.3. Carl Gustav

Participants were required to rate the compatibility of each vest condition with the Carl Gustav both as the “Number One” or firer, and as the “Number Two” or loader. Results for each vest condition are described below in Figures 14 and 15.



Annex G: Compatibility

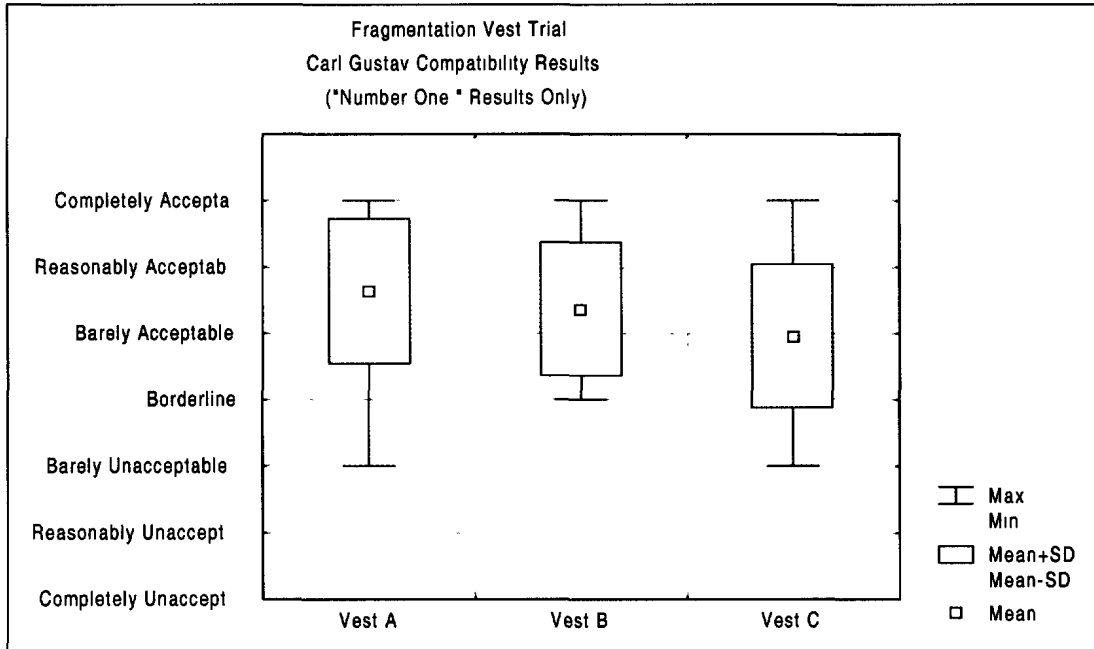


Figure 14: Carl Gustav "Number One" Compatibility Results

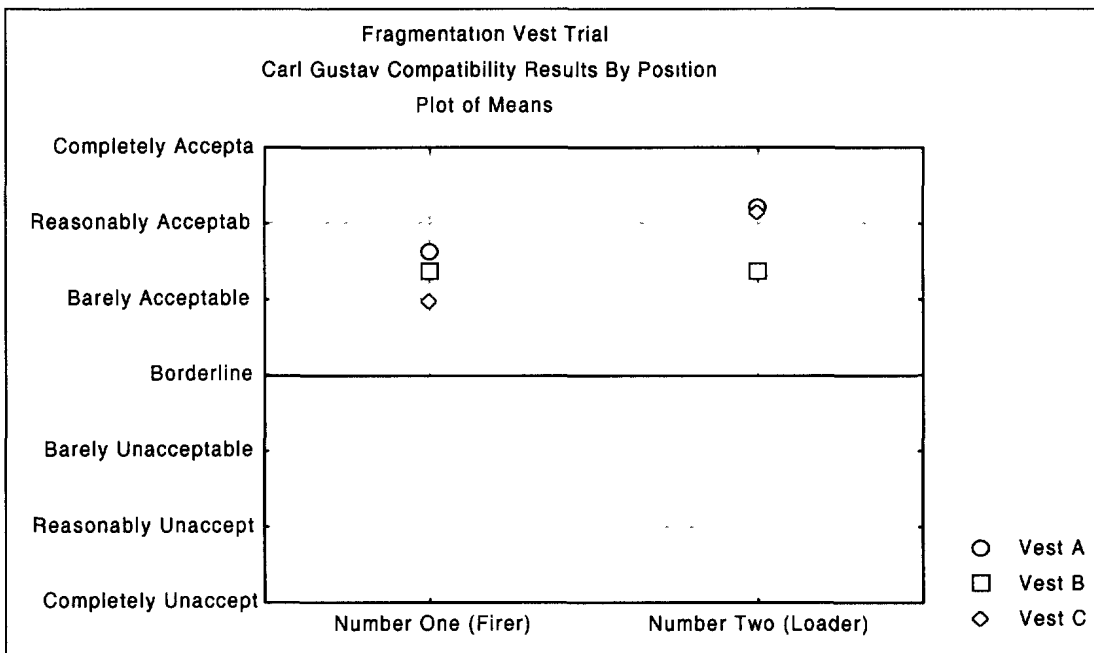
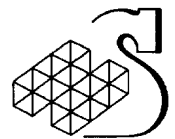


Figure 15: Carl Gustav Compatibility Results by Position



Annex G: Compatibility

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest C for Carl Gustav compatibility (Number One Firer Only) without plates (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for Carl Gustav compatibility (Number Two - loader) without plates (*Barely to Reasonably Acceptable*). The excess material in the shoulder girth of Vest B caused material bunching in the upper back of participants, especially when loading 84mm dummy rounds. The cumbersome shoulder pads and elastic attachment strap also restricted movement with Vest B.

Vest C: Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A for Carl Gustav compatibility (Number One Firer Only) without plates (*Borderline to Barely Acceptable*). Additionally, weapon compatibility with Vest C while wearing plates was problematic due to plate interference and vest instability.

3.1.4. M72 Rocket launcher

Participants were required to rate the compatibility of each vest condition with the M72 Rocket launcher. Results for each vest condition are described below in Figure 16.

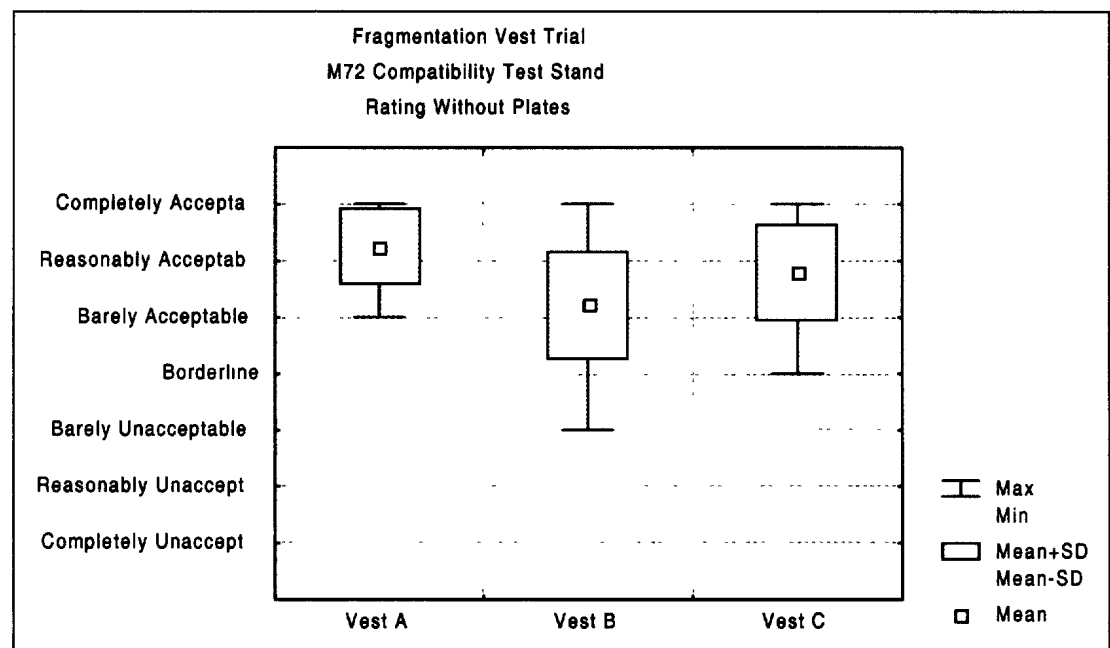
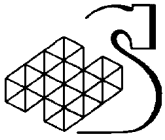


Figure 16: M72 Compatibility Results

3.2. Clothing and Equipment

Participants were required to rate the compatibility of each vest condition with the IECS Jacket, IECS Parka, and Temperate Combat Gloves. Results for each vest condition are described below.



Annex G: Compatibility

3.2.1. IECS Jacket and Parka

Mean ratings for clothing compatibility with and without plates are displayed in Figure 17 below. The no-fragmentation vest condition was significantly ($p < 0.05$) more acceptable for compatibility with the IECS Jacket and Parka than Vests A, B or C. The addition of ceramic plates made all vests less compatible with the IECS jacket and Parka.

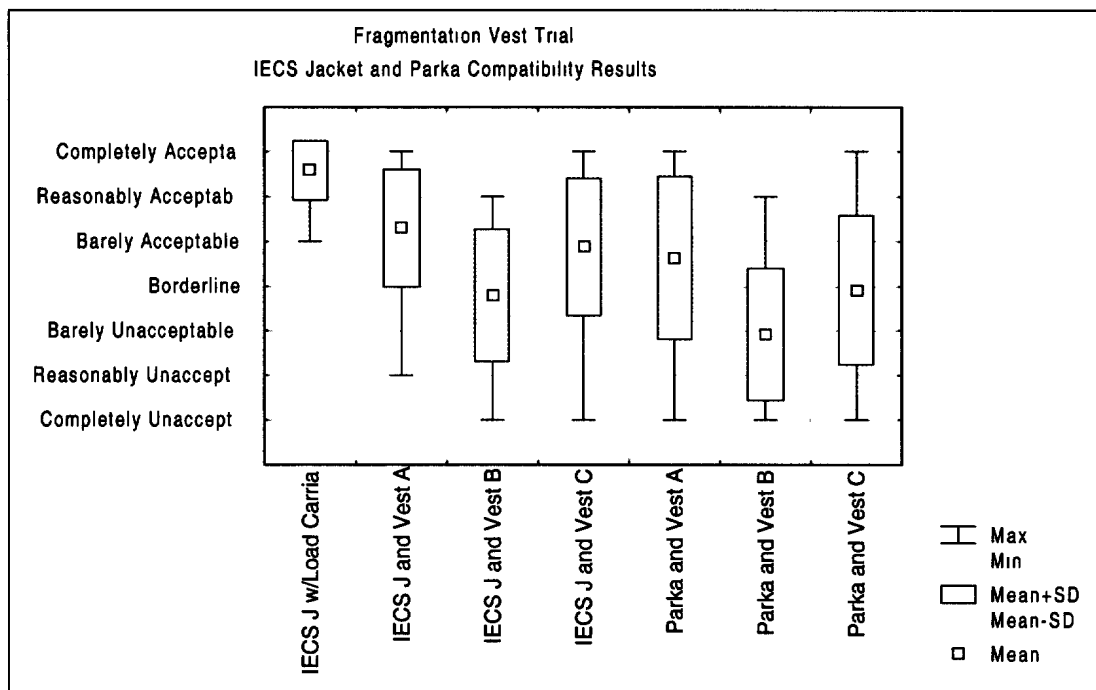


Figure 17: Compatibility with IECS Jacket and Parka Results

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for IECS Jacket and IECS Parka compatibility (*Barely to Reasonably Acceptable and Borderline to Barely Acceptable*). While Vest A was bulkier than Vest C, participants could still adjust their vest (shoulder and side straps) to fit overtop the IECS Jacket and bulky IECS Parka.

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for IECS Jacket and IECS Parka compatibility (*Borderline to Barely Unacceptable and Barely to Reasonably Unacceptable*). The bulkiness of Vest B and its one shoulder adjustment design made it problematic to wear with any jacket combination.

Vest C: Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for IECS Jacket and IECS Parka compatibility (*Borderline to Barely Acceptable and Borderline to Barely Unacceptable*). Participants could adjust Vest C to fit overtop jackets and parkas if required. The design of vest C also allows it to be worn underneath the parka while the fixed collar of Vest A and the fixed collar and shoulder's of Vest B make this difficult.



Annex G: Compatibility

3.2.2. Temperate Combat Gloves

Mean ratings for combat glove compatibility with vests is displayed in Figure 18 below. All of the subjects expressed difficulty in assembling and adjusting their fragmentation vests while wearing the in-service combat gloves. Whereas adjustability for barehanded operation was acceptable (see Annex C), adjustability with the combat gloves was borderline.

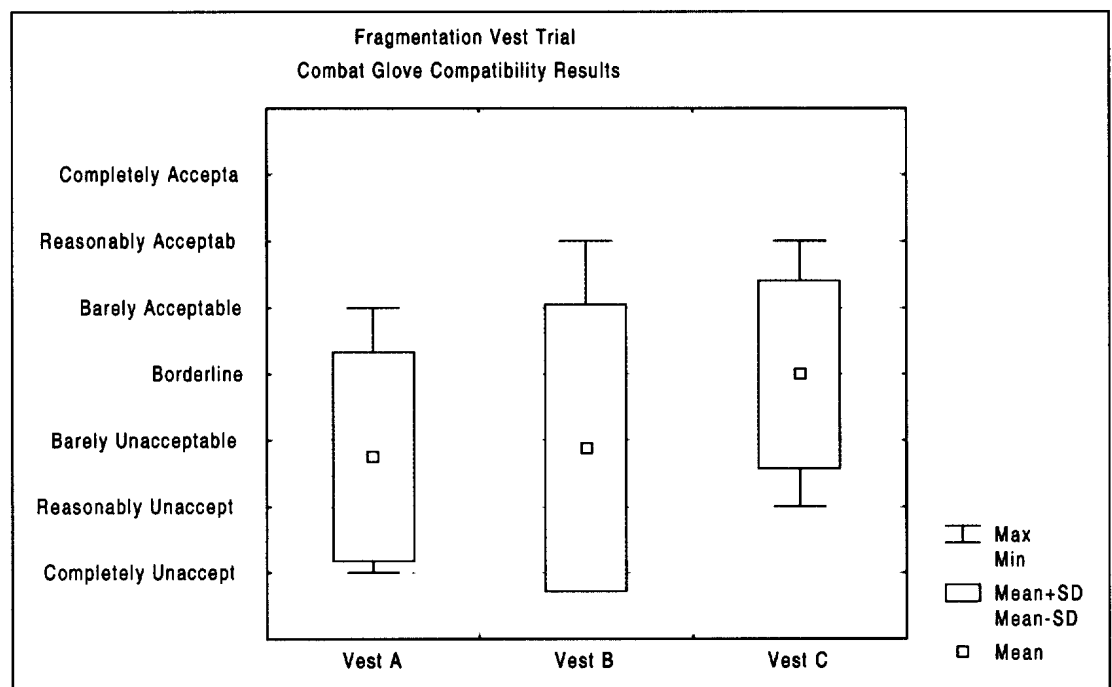


Figure 18: Compatibility with Combat Gloves

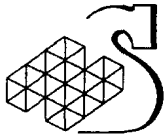
Vest A: Vest A's compatibility with the in-service combat gloves was rated as being unacceptable (*Barely to Reasonably Unacceptable*).

Vest B: Vest B's compatibility with the in-service combat gloves was rated as being unacceptable (*Barely to Reasonably Unacceptable*).

Vest C: Vest C's compatibility with the in-service combat gloves was rated as being significantly more acceptable than Vests A and B (*Borderline*). The reason being that all the vest C's were used and therefore more pliable, making them more accessible and adjustable.

3.3. Vehicles

Compatibility with the MLVW and Bison vehicles was assessed with each vest condition. Compatibility with the MLVW was also assessed with participants wearing vests with plates. Mean ratings for vehicle compatibility are summarized below in Figures 19 to 21.



Annex G: Compatibility

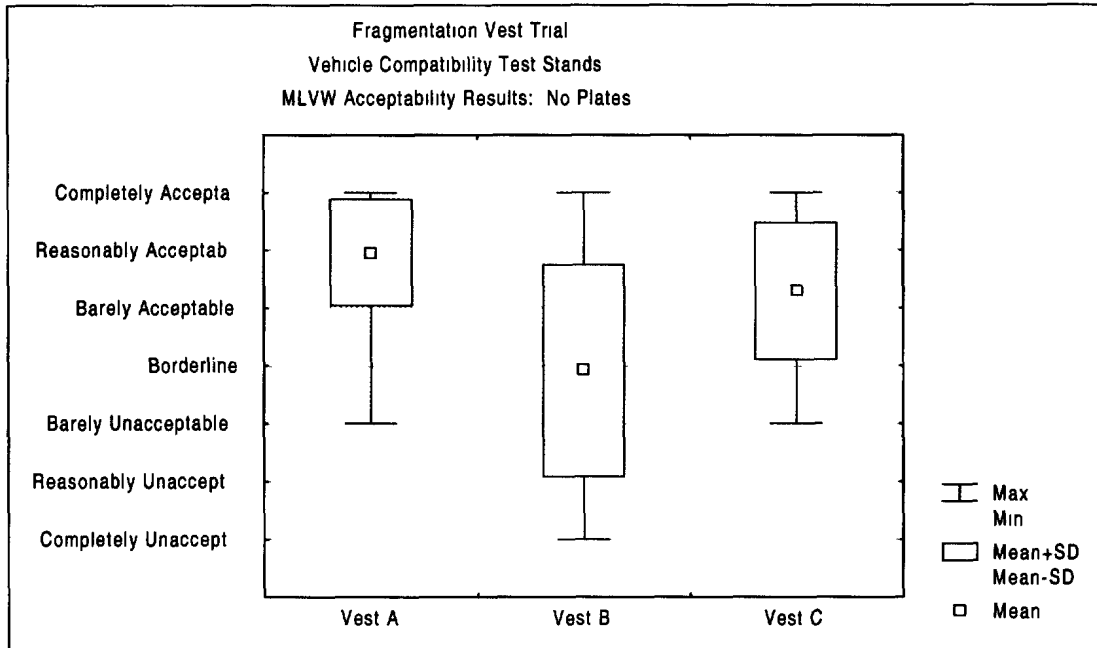


Figure 19: Compatibility with MLVW (no plate condition)

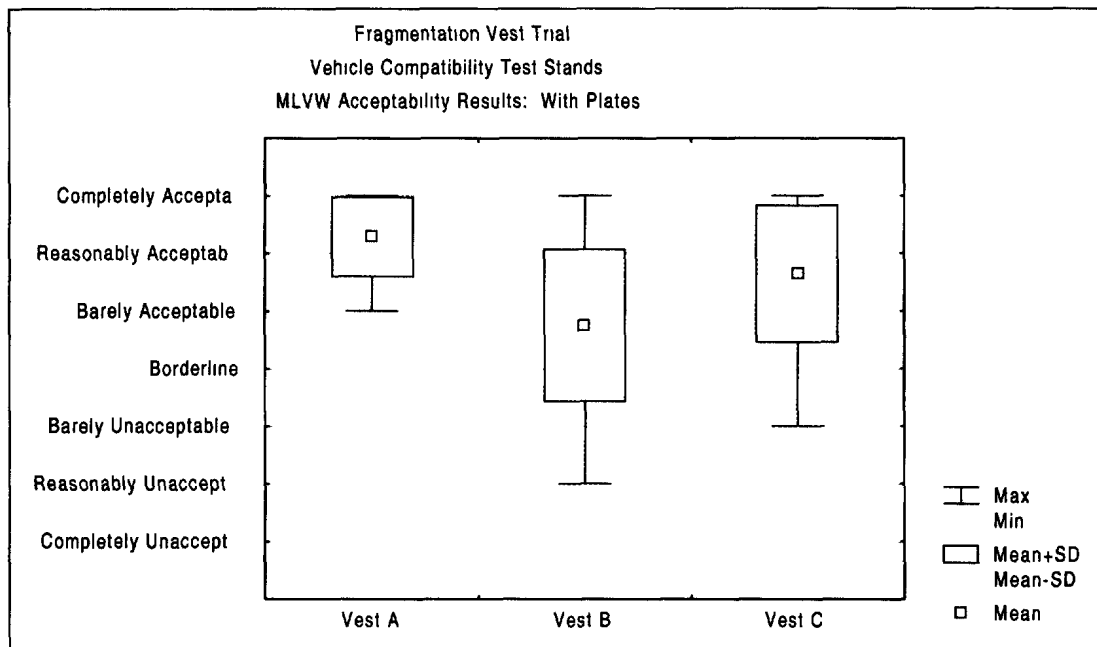
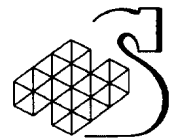


Figure 20: Compatibility with MLVW (with plate condition)



Annex G: Compatibility

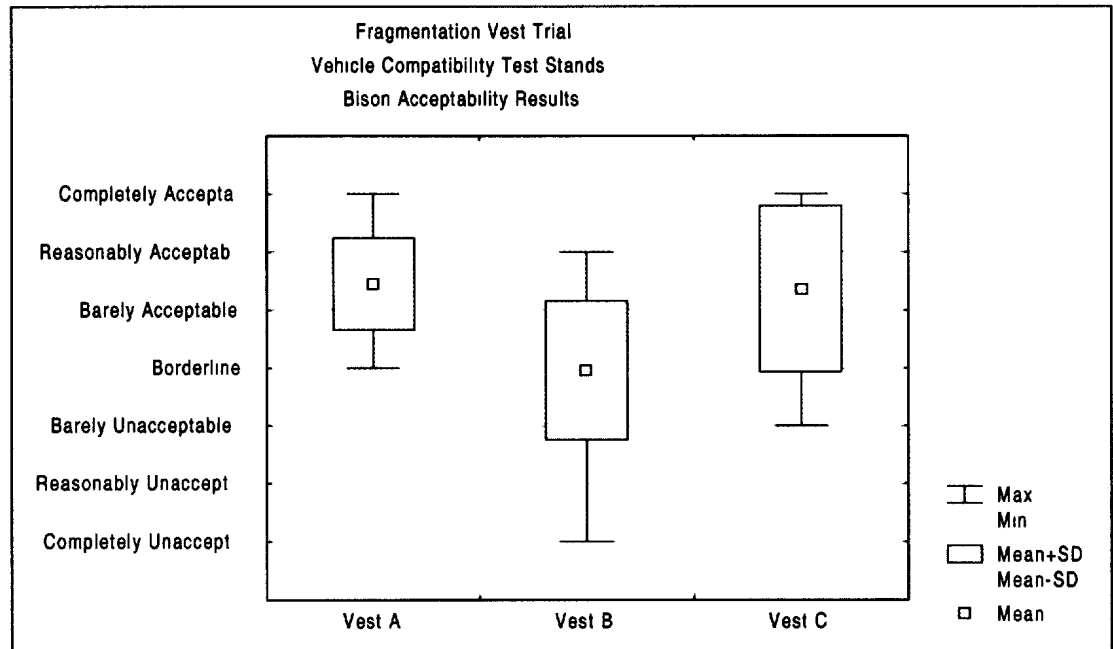
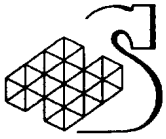


Figure 21: Compatibility with Bison (no plate condition)

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for MLVW compatibility with and without plates (*Barely to Reasonably Acceptable and Reasonably to Completely Acceptable*). Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for Bison compatibility without plates (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for MLVW compatibility with and without plates (*Barely Unacceptable to Borderline and Borderline to Barely Acceptable*). Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for Bison compatibility without plates (*Barely Unacceptable to Borderline*).

Vest C: Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for MLVW compatibility with and without plates (*Barely to Reasonably Acceptable*). Vest C was rated significantly ($p < 0.05$) more acceptable than Vests B for Bison compatibility without plates (*Barely to Reasonably Acceptable*).



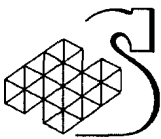
Annex G: Compatibility

4. Discussion

Compatibility ratings for weapons, clothing and equipment as well as vehicles were significantly more favourable for Vest A and C over Vest B. The reduced coverage designs and multiple adjustment points on Vests A and C were ideal for accommodating the fitting and wear restrictions imposed by the IECS outer jackets tested during this trial. The long torso, high collar and bulky shoulder design of vest B, coupled with its inability to affect sizing adjustments, resulted in its lower compatibility acceptability ratings with most items and vehicles.

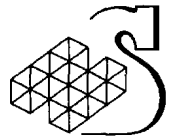
The shoulder design of Vest C caused notable compatibility problems with rifle butt slippage in the prone position.

In order to achieve appropriate relief with the C79 sight, the C7 rifle is available with optional butt spacers. The system is designed such that spacers are used to help users achieve proper eye relief when sighting the rifle, with and without fragmentation vests. If the rifle butt length is held constant, the optimum sight position on the mounting rail is different for users not wearing a fragmentation vest as with users wearing a fragmentation vest. While many users can adjust the sight without further modifications, a number of users do not have enough adjustment; thus removable butt lengths are used to allow these users can achieve a proper eye relief for either condition. C7 rifles with modified butt lengths were not available for this trial and thus the requirement for them with the fragmentation vests is unknown.



**Annex H:
Combat Activities**

**ANNEX H:
Combat Activities**



Annex H: Combat Activities

1. Introduction

Soldier performance while wearing the fragmentation vests in combat activities were evaluated for obstacle course trials, grenade throwing, casualty handling and vehicle inspection.

2. Method

Fragmentation vest effects on the performance of military combat and peacekeeping tasks were evaluated for selected activities (obstacle course, grenade throw, range firing, and civilian vehicle inspection).

2.1. Obstacle Course:

Participants surmounted a number of individual obstacles consecutively as part of single course. Participants performed these tests in their assigned fragmentation vest/fighting order conditions. At the completion of the obstacle course for each condition, participants were required to complete a Task Questionnaire. For each obstacle, participants wore their helmet and carried their personal weapon see Figures 1 and 2.

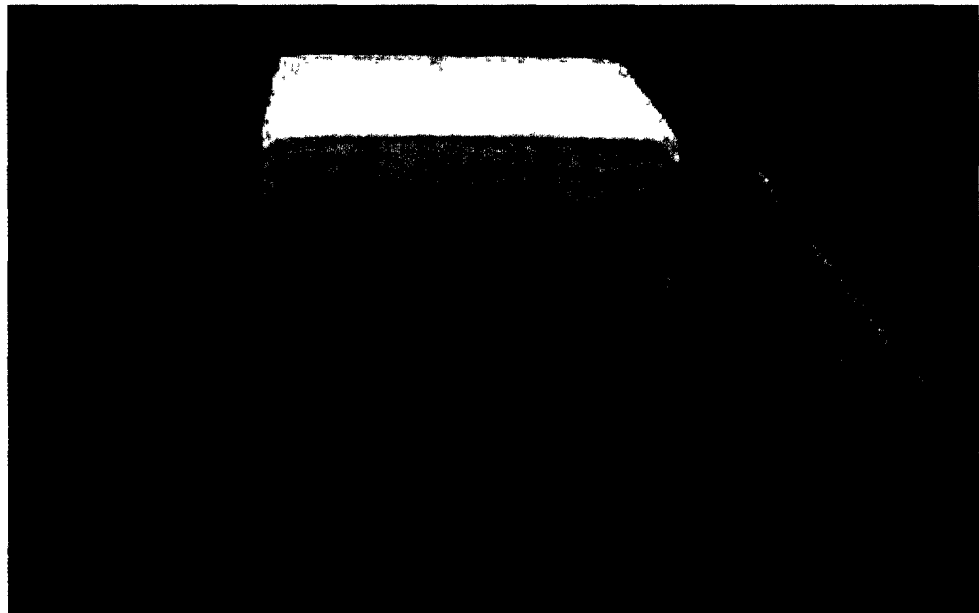
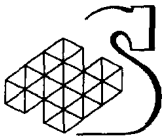


Figure 1: Mouse Hole Obstacle



Annex H: Combat Activities



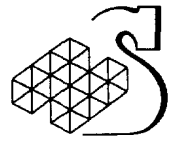
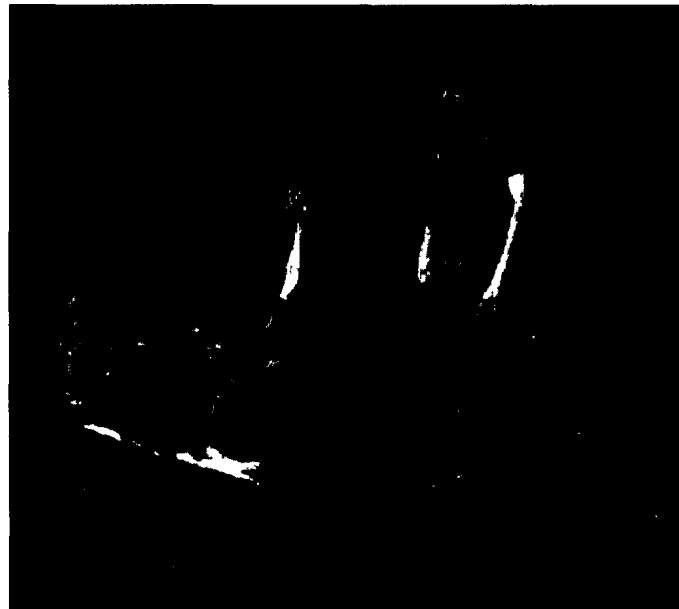
Figure 2: Wall Obstacle

The following obstacles were used:

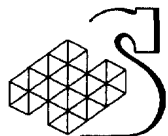
- **100m Dash:** Sprint 100m.
- **Ladder Obstacle:** Ascend a 10m ladder, straddle and traverse the top bar, then descend the ladder to the ground.
- **Crawl:** Perform a Leopard crawl while traversing a 10m low wire obstacle.
- **Wall Obstacle:** Run 3m and climb (assisted) over a 2.4m high wall.
- **Pit Obstacle:** Run up a 2m ramp and jump down into a sand pit and perform a forward roll.
- **Over and Under Obstacle:** Climb over and under five successive poles mounted 0.5 and 1.0 meter from the ground.
- **Mouse Hole Obstacle:** Crawl through a square, concrete mouse hole shaft for 1m and climb over and under three successive poles mounted 0.5m, 1.0m, and 0.5m above the ground.

2.2. Grenade Throw:

Participants were required to throw a dummy grenade in each fragmentation vest/load carriage condition assigned into a target circle (6 meter diameter) from a prone position at a distance of 15 meters – see Figure 3. Participants indicated a performance rating score for each condition and HF observers recorded whether the grenade landed in the target circle.

**Annex H:
Combat Activities****Figure 3: Grenade Throwing*****2.3. Civilian Vehicle Inspection:***

This drill was designed to simulate the civilian vehicle inspection procedures required during peacekeeping roadblock checkpoints. Inspection activities included a standing inspection of the exterior bodywork, kneeling inspection of a wheel well, prone inspection of the car underside below the trunk, and stooped/crouched inspection of the passenger seat area – see Figure 4. Participants indicated a performance rating score for each condition and HF observers recorded the ease of performance.



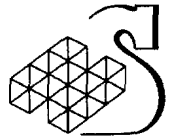
Annex H: Combat Activities



Figure 4: Vehicle Inspection

2.4. First Aid Removal:

Working in pairs, participants were required to simulate vest removal from a supine, injured soldier – see Figure 5. Participants rated the ease of removal, both as the first aid provider and as the injured participant. HF observers evaluated the ease of vest removal and the extent of injured soldier movement/handling required.



Annex H: Combat Activities



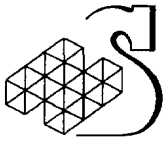
Figure 5: Casualty Removal

3. Results

3.1. Obstacle Course

The Obstacle Course Task Questionnaire Results (Mean Ratings) are summarized below in Figures 6 and 7. Statistical significant ($p < 0.05$) differences are indicated.

Overall, Vest B was rated as being unacceptable for the obstacle course task and was significantly ($p < 0.05$) less acceptable than the No Vest condition or Vests A and C. Vests A and C were rated as being acceptable for performance of the obstacle course battle task.



Annex H: Combat Activities

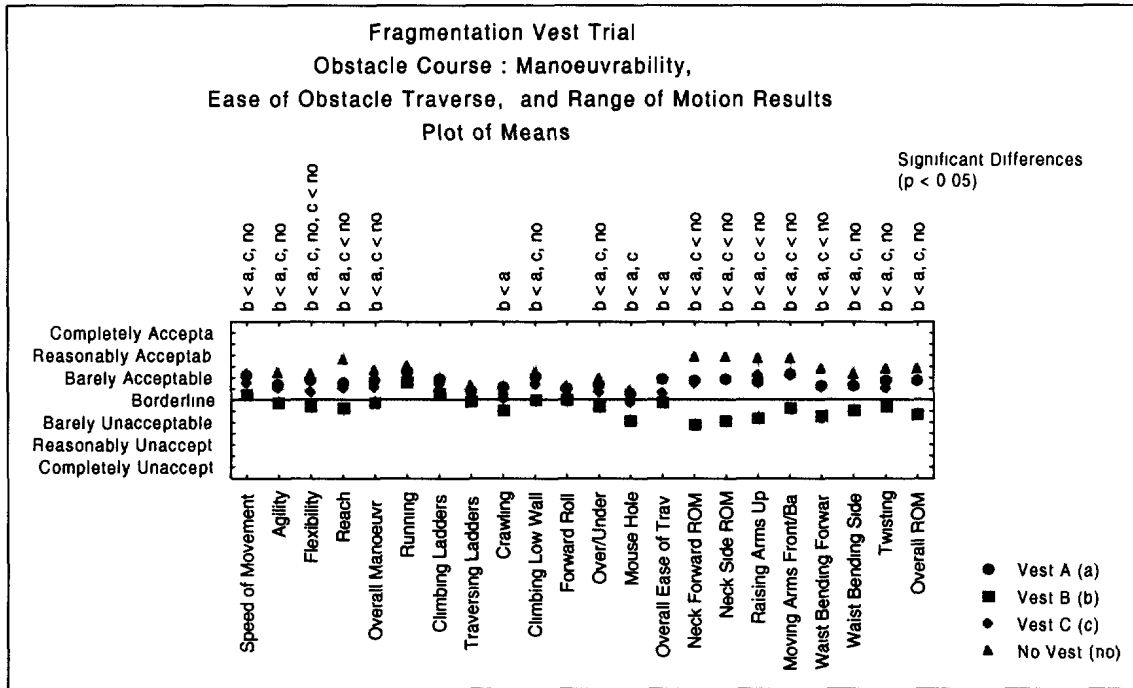


Figure 6: Obstacle Course Task Questionnaire Results (Questions 1-22)

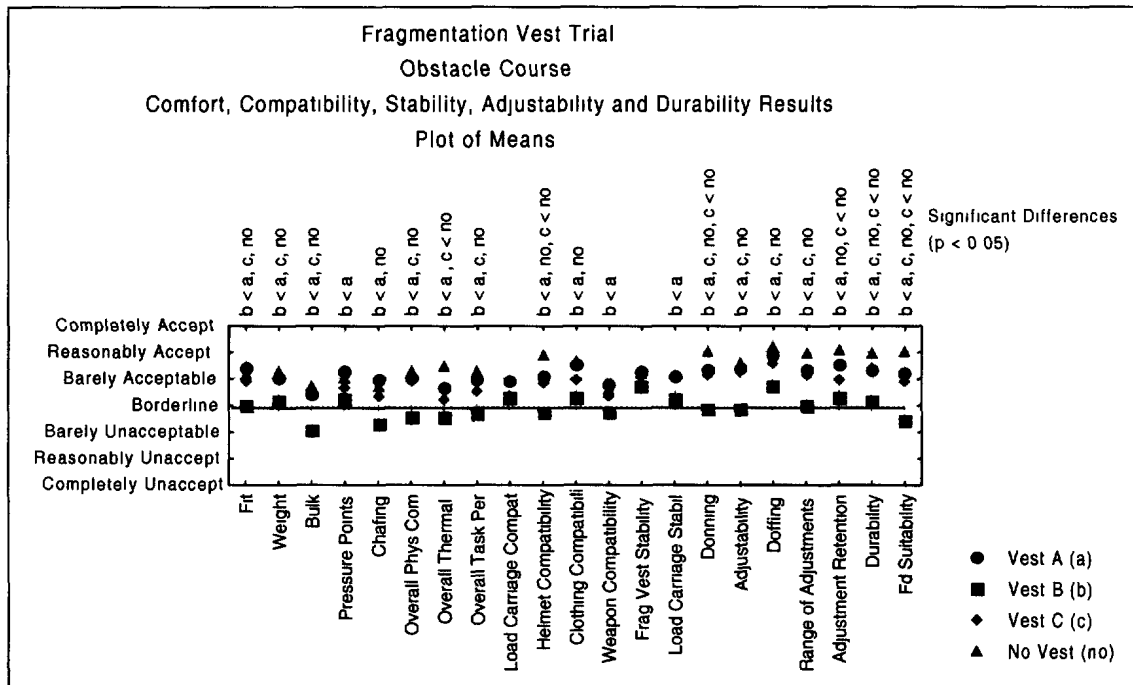
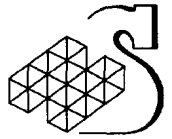


Figure 7: Obstacle Course Task Questionnaire Results (Questions 23-43)



Annex H: Combat Activities

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for Overall Manoeuvrability, Overall Ease of Obstacle Traverse, Overall Range of Motion, and Overall Task Performance (*Borderline to Barely Acceptable*). Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for Suitability for Field Use (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A and C for Overall Manoeuvrability, Overall Range of Motion, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Unacceptable*). Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for Ease of Obstacle Traverse (*Borderline to Barely Unacceptable*).

Vest C: Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for Overall Manoeuvrability, Overall Range of Motion, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Acceptable*).

3.2. Grenade Throw

Mean ratings and standard deviations for ease of grenade throwing while wearing the vests are summarized below in Figure 8. Due to the hard surface of the target area, the dummy grenades thrown frequently rolled out of the target zone and thus were not representative of the accuracy achievable on a grassed surface. As a result, grenade throwing accuracy will not be presented.

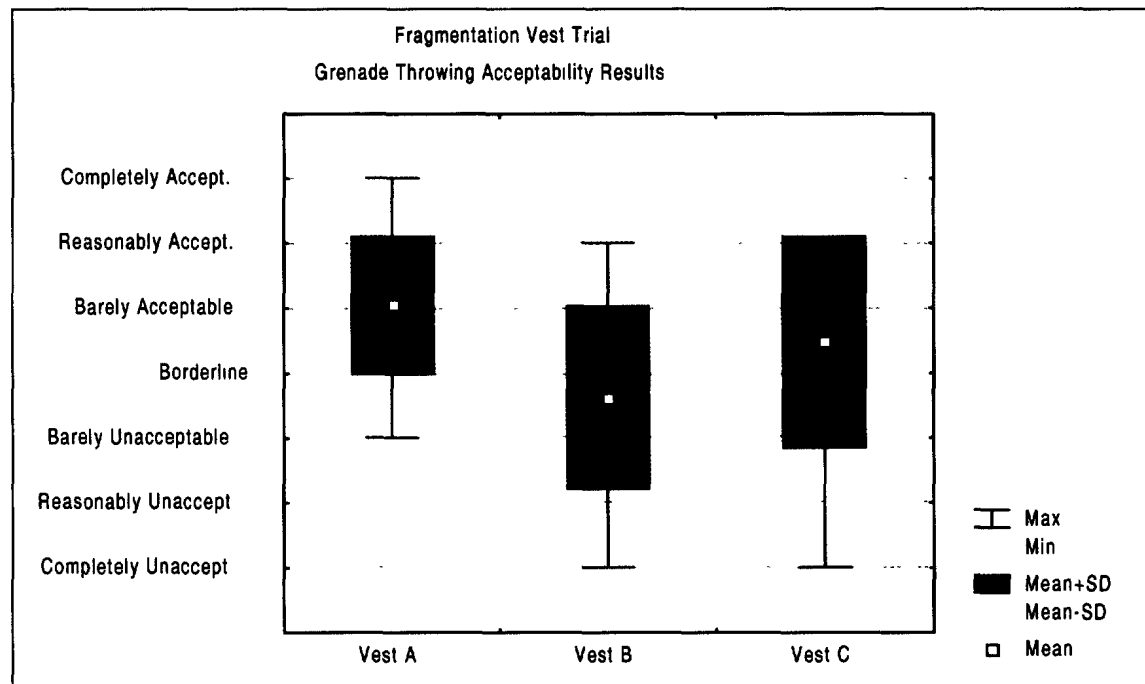


Figure 8: Grenade Throwing Acceptability Results



**Annex H:
Combat Activities**

Vest B was rated as being unacceptable (*Borderline to Barely Unacceptable*) for the grenade throwing task and was rated significantly ($p<0.05$) less acceptable than Vests A and C. Vest A was rated as being acceptable (*Barely to Reasonably Acceptable*) for the grenade throwing task. Vest C was also rated as being acceptable (*Borderline to Barely Acceptable*) for the grenade throwing task. While grenade throwing performance was somewhat reduced while wearing any fragmentation vest, the bulk of Vest B and its restrictions to shoulder and neck movement greatly affected the participants acceptability ratings.

3.3. Vehicle Inspection

Mean ratings and standard deviations for ease of vehicle inspection while wearing the vests are summarized below in Figure 9.

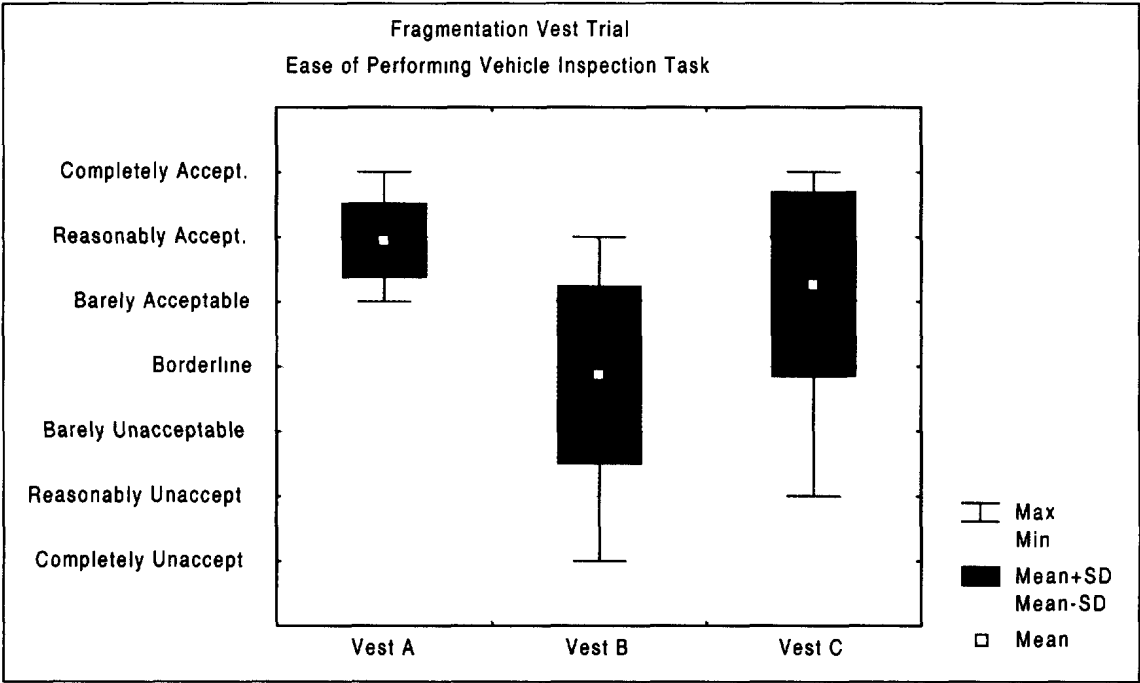
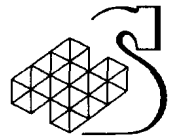


Figure 9: Vehicle Inspection Acceptability Results

Vest B was rated as being unacceptable (*Borderline to Barely Unacceptable*) for the vehicle inspection task and was rated significantly ($p<0.05$) less acceptable than Vests A and C. Vest A was rated as being acceptable (*Barely to Reasonably Acceptable*) for the vehicle inspection task. Vest A was rated significantly ($p<0.05$) more acceptable than Vest C. Vest C was also rated as being acceptable (*Barely to Reasonably Acceptable*) for the vehicle inspection task. While vehicle inspection performance was somewhat reduced while wearing any fragmentation vest, the bulk of Vest B and its restrictions to shoulder and neck movement greatly affected the participants acceptability ratings.



Annex H: Combat Activities

3.4. Casualty Handling

Mean ratings and standard deviations for casualty evacuation from an injured soldier wearing a vest are summarized below in Figure 10.

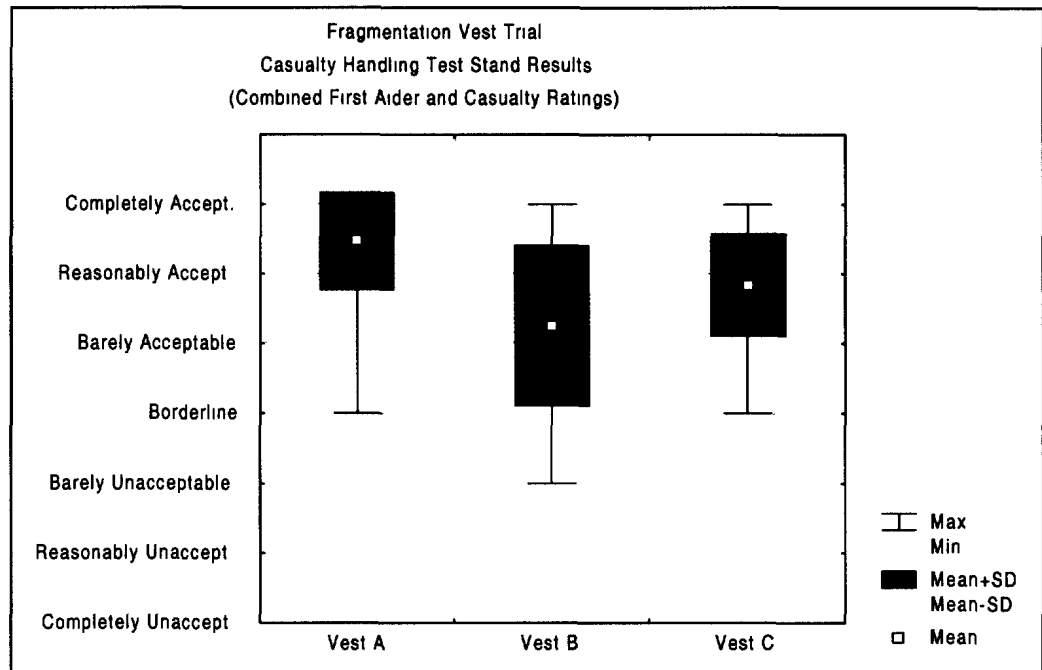
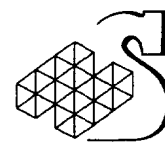


Figure 10: Casualty Handling Test Results

All vest conditions were rated as being acceptable for casualty extraction. Vest B was rated as being significantly ($p < 0.05$) less acceptable than Vests A and C for casualty extraction (*Reasonably to Completely Acceptable*). Vest C was also rated as being acceptable (*Barely to Reasonably Acceptable*) for the casualty handling task. The two shoulder adjustment features of Vests A and C made it much easier to extract casualties from their vest as compared to Vest B which had one fixed shoulder. The locking velcro flap on Vest C's shoulder strap required more effort to release as compared to the non-locked velcro shoulder strap of Vest A.

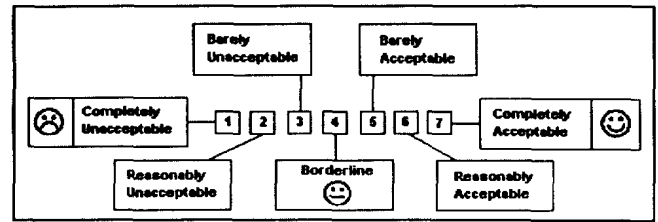
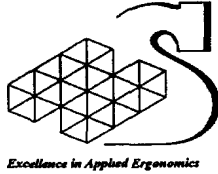
4. Discussion

For all combat activities tested, Vest B was rated as the least acceptable vest and for many activities Vest B was also rated as being unacceptable. Vest A was rated the most acceptable vest for most of the combat activity tasks. Perceived vest performance in the combat activities appeared to be most affected by vest bulk, loss of range of motion, compatibility with equipment and weapons and inadvertent snagging.



**Appendix 1 to Annex H:
Combat Activities**

**APPENDIX 1 TO ANNEX H:
Obstacle Course Questionnaire**

**PERSONAL DATA**

Clearly print your Name, Subject Number and Vest Type in the boxes provided.

NAME

--	--	--	--	--	--	--	--	--	--	--	--

SUBJECT NUMBER

--	--

Obstacle Traverse Serial # _____

 FRAGMENTATION VEST TYPE: None: ☐ Vest A: ☐ Vest B: ☐ Vest C: ☐

FRAG VEST NUMBER: _____

 LOAD CARRIAGE TYPE: 82 Pattern Webbing: ☐ TAV: ☐
INSTRUCTIONS

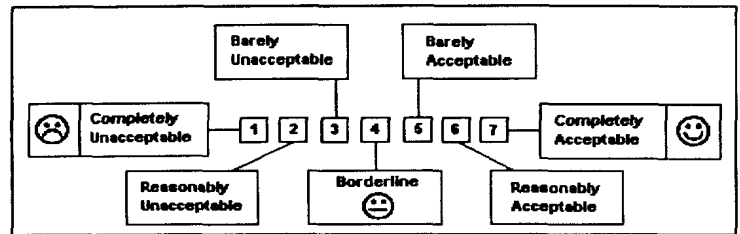
Please provide a rating of acceptance for manoeuvrability, range of motion, compatibility, ease of traverse, comfort, stability, adjustability and overall acceptance, using the 7-point scale above, for acceptability to perform obstacle.

COMMENTS

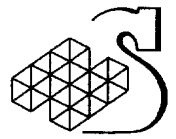
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OBSTACLE COURSE TASK:

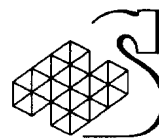


Manoeuvrability	☹ 1 2 3 4 5 6 7 ☺	Range of Motion	☹ 1 2 3 4 5 6 7 ☺
Speed of Movement	○ ○ ○ ○ ○ ○ ○ ○	Neck Forward/Back	○ ○ ○ ○ ○ ○ ○ ○
Agility	○ ○ ○ ○ ○ ○ ○ ○	Neck Side to Side	○ ○ ○ ○ ○ ○ ○ ○
Flexibility	○ ○ ○ ○ ○ ○ ○ ○	Raising Arms up	○ ○ ○ ○ ○ ○ ○ ○
Reach	○ ○ ○ ○ ○ ○ ○ ○	Moving Arms to Front/Back	○ ○ ○ ○ ○ ○ ○ ○
Overall Manoeuvrability	○ ○ ○ ○ ○ ○ ○ ○	Waist Bending Forward/Back	○ ○ ○ ○ ○ ○ ○ ○
Ease of Obstacle Traverse	☹ 1 2 3 4 5 6 7 ☺	Waist bending Side to Side	○ ○ ○ ○ ○ ○ ○ ○
Running	○ ○ ○ ○ ○ ○ ○ ○	Twisting	○ ○ ○ ○ ○ ○ ○ ○
Climbing/Descending Ladders	○ ○ ○ ○ ○ ○ ○ ○	Overall Range of Motion	○ ○ ○ ○ ○ ○ ○ ○
Traversing Ladder	○ ○ ○ ○ ○ ○ ○ ○	Compatibility	☹ ☹ ☹ ☹ ☹ ☹ ☹ ☹
Crawling	○ ○ ○ ○ ○ ○ ○ ○	Load Carriage	○ ○ ○ ○ ○ ○ ○ ○
Climbing Low Wall	○ ○ ○ ○ ○ ○ ○ ○	Helmets	○ ○ ○ ○ ○ ○ ○ ○
Forward Roll	○ ○ ○ ○ ○ ○ ○ ○	Clothing	○ ○ ○ ○ ○ ○ ○ ○
Over/Under	○ ○ ○ ○ ○ ○ ○ ○	Weapons	○ ○ ○ ○ ○ ○ ○ ○
Mouse Hole	○ ○ ○ ○ ○ ○ ○ ○	Stability	☹ ☹ ☹ ☹ ☹ ☹ ☹ ☹
Overall Ease of Traverse	○ ○ ○ ○ ○ ○ ○ ○	Fragmentation Vest Stability	○ ○ ○ ○ ○ ○ ○ ○
Comfort	☹ ☹ ☹ ☹ ☹ ☹ ☹ ☹	Load Carriage Stability	○ ○ ○ ○ ○ ○ ○ ○
Fit	○ ○ ○ ○ ○ ○ ○ ○	Adjustment/Durability	☹ ☹ ☹ ☹ ☹ ☹ ☹ ☹
Weight	○ ○ ○ ○ ○ ○ ○ ○	Put On	○ ○ ○ ○ ○ ○ ○ ○
Bulk	○ ○ ○ ○ ○ ○ ○ ○	Adjust Fit	○ ○ ○ ○ ○ ○ ○ ○
Pressure Points	○ ○ ○ ○ ○ ○ ○ ○	Take Off	○ ○ ○ ○ ○ ○ ○ ○
Chaffing	○ ○ ○ ○ ○ ○ ○ ○	Range of Adjustments	○ ○ ○ ○ ○ ○ ○ ○
Overall Physical Comfort	○ ○ ○ ○ ○ ○ ○ ○	Adjustment Retention	○ ○ ○ ○ ○ ○ ○ ○
Overall Thermal Comfort	○ ○ ○ ○ ○ ○ ○ ○	Durability	○ ○ ○ ○ ○ ○ ○ ○
Overall Task Performance	○ ○ ○ ○ ○ ○ ○ ○	Suitability for Field Use	○ ○ ○ ○ ○ ○ ○ ○



**Annex I:
Range Firing**

**ANNEX I:
Range Firing**



Annex I: Range Firing

1. Introduction

Range firing was undertaken to evaluate the compatibility effects of the three vest conditions for the C7A1 rifle and the C9 LMG.

2. Method

2.1. C7A1 Rifle

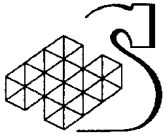
Participants performed a modified Personal Weapons Test (PWT) with the C7A1 rifle in each vest condition – see Figure 1. The modified programme including a preliminary zeroing serial followed by a scored grouping test and then a modified run-down test - see Appendix 1. After each set of range firing serials, participants completed a C7 Range Firing Task Questionnaire. Range scores were recorded for each weapon and vest condition. Additionally, eight infantrymen repeated the firing serials while wearing plates with the three vest conditions.



Figure 1: Participant Wearing Vest A Performing C7A1 Range Practice

2.2. C9 LMG

Participants performed a familiarization shoot with the C9 LMG in each vest condition – see Figure 2. Following each set of range firing serials, participants completed a C9 LMG Range Firing Task Questionnaire. Range scores were not recorded.



Annex I: Range Firing



Figure 2: C9 LMG Familiarization Practice

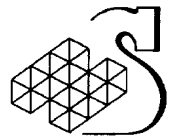
3. Results

Results are summarized below for the C7A1 rifle and C9 LMG.

3.1. C7A1 Rifle

3.1.1. Range Scores

Mean ratings and standard deviations for C7A1 rifle firing scores for all participants is summarized below (Figure 3) for each vest. An analysis of the range firing scores did not identify any significant difference between any fragmentation vest conditions (without plates). Eight infantry soldiers performed the range practice while wearing fragmentation vests and plates. (Note Vest C was performed with just the front plate). While the infantrymen had less variability in their range scores (see Figure 4) than the combined trial personnel, the differences between vests was not significant.



Annex I: Range Firing

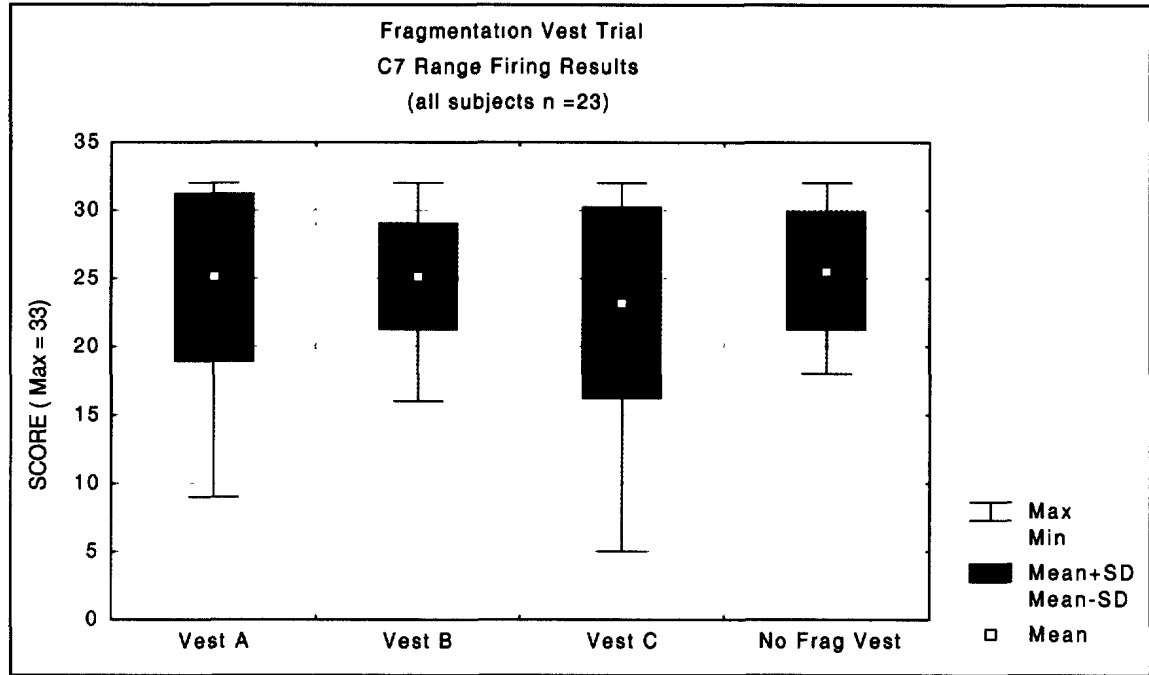


Figure 3: C7 Range Firing Results (All)

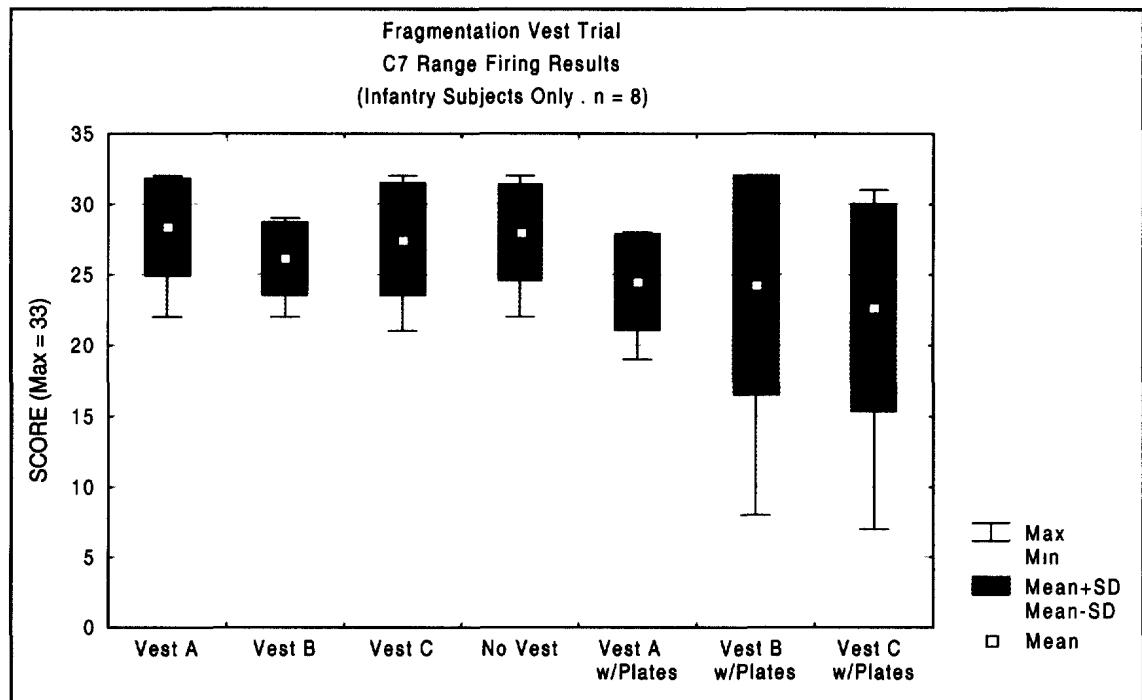
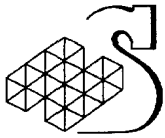


Figure 4: C7 Range Firing Results –Infantry Participants With and Without Plates



Annex I: Range Firing

3.1.2. Range Firing Questionnaire Results

Mean ratings for the C7A1 Rifle Firing Task Questionnaire results are summarized below in Figures 5 and 6. Overall, Vest B was rated as being unacceptable for the C7A1 Rifle Firing Task and was significantly ($p < 0.05$) less acceptable than the No Vest condition or Vest A. The No Vest, Vest A and Vest C conditions were rated as being acceptable for C7A1 rifle firing. Select C7 Range Firing Task Questionnaire results are summarized below:

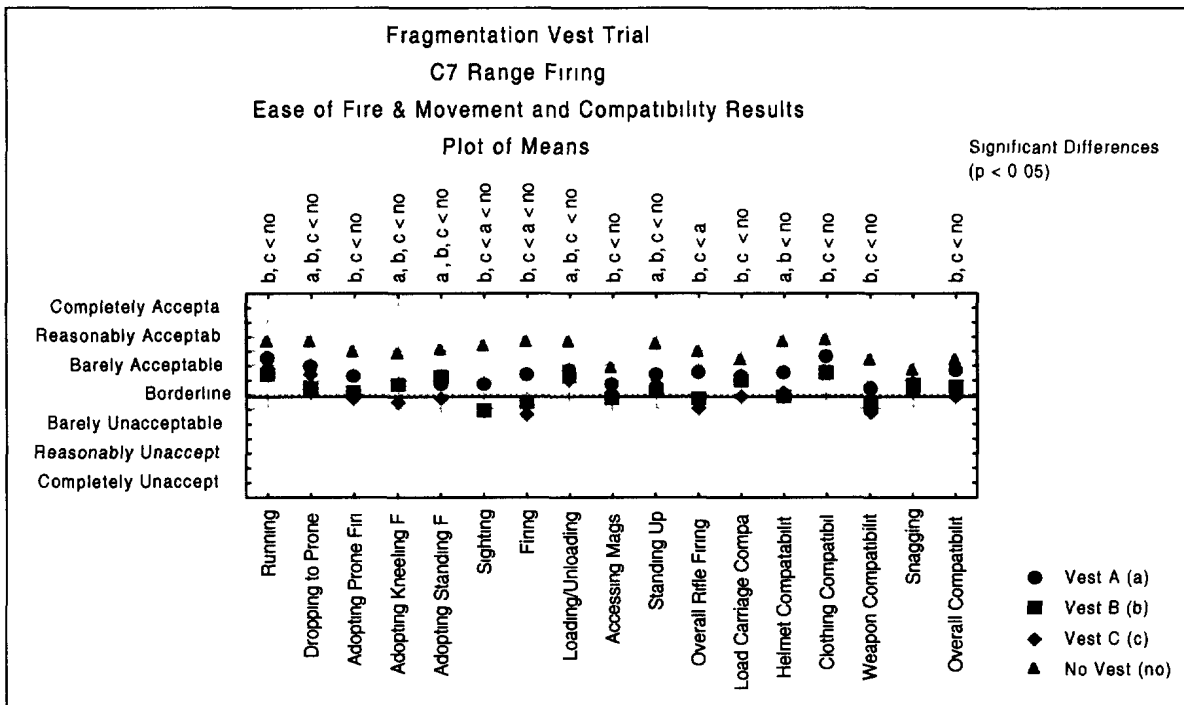
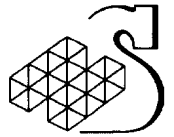


Figure 5: C7 Range Firing Task Questionnaire Results (Questions 1–17)



Annex I: Range Firing

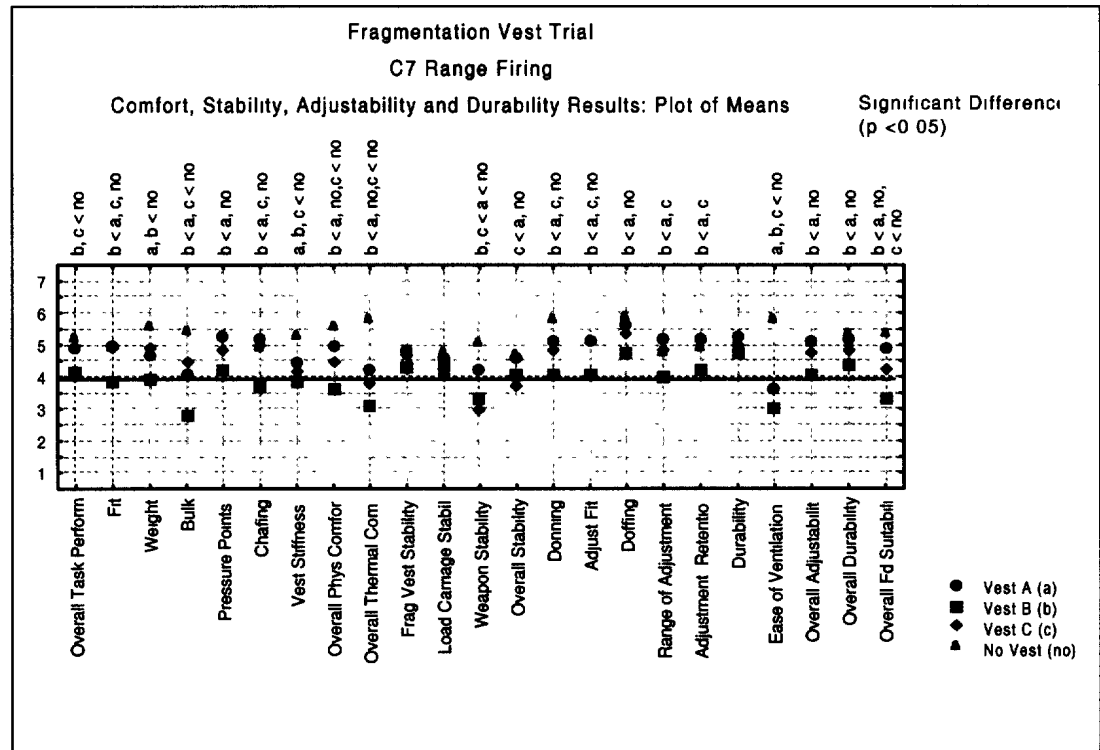
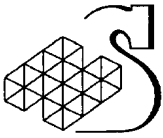


Figure 6: C7 Range Firing Task Questionnaire Results (Questions 18– 41)

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for Suitability for Field Use and Overall Rifle Firing Performance (*Borderline to Barely Acceptable*). Vest A was also rated acceptable for Overall Compatibility and Overall Task Performance (*Borderline to Barely Acceptable*). Some concerns with weapon butt plate slippage were noted with Vest A.

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for Overall Rifle Firing Performance, Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Unacceptable*). Participants noted problems with vest bulk, excessive vest length, neck discomfort, and weapon butt plate slippage.

Vest C: Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A for Overall Rifle firing Performance (*Borderline to Barely Unacceptable*). Vest C was also rated acceptable for Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Acceptable*). A number of subjects had problems finding a stable rifle butt position in the prone position.



Annex I: Range Firing

3.2. C9 LMG

Mean ratings for the C9 LMG firing Task Questionnaire results are summarized below in Figures 7 and 8. All vest conditions were rated as being acceptable for C9 LMG Firing. Overall, Vest B was rated as being significantly ($p < 0.05$) less acceptable than Vests A and the No Vest condition for the C9 LMG battle task. Vests A and C were also rated as being significantly ($p < 0.05$) less acceptable than the No Vest condition for the C9 LMG battle task. Select C9 LMG Range Firing Task Questionnaire results are summarized below:

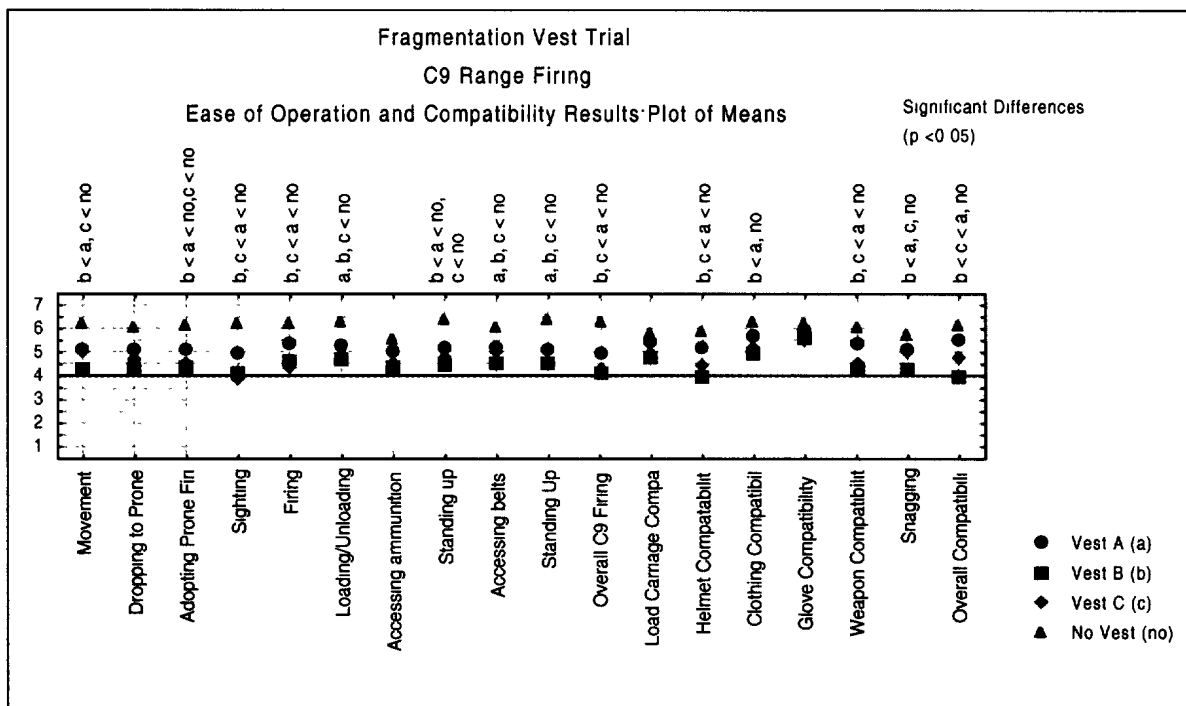
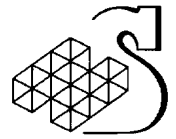


Figure 7: C9 LMG Task Questionnaire Results (Questions 1-18)



Annex I: Range Firing

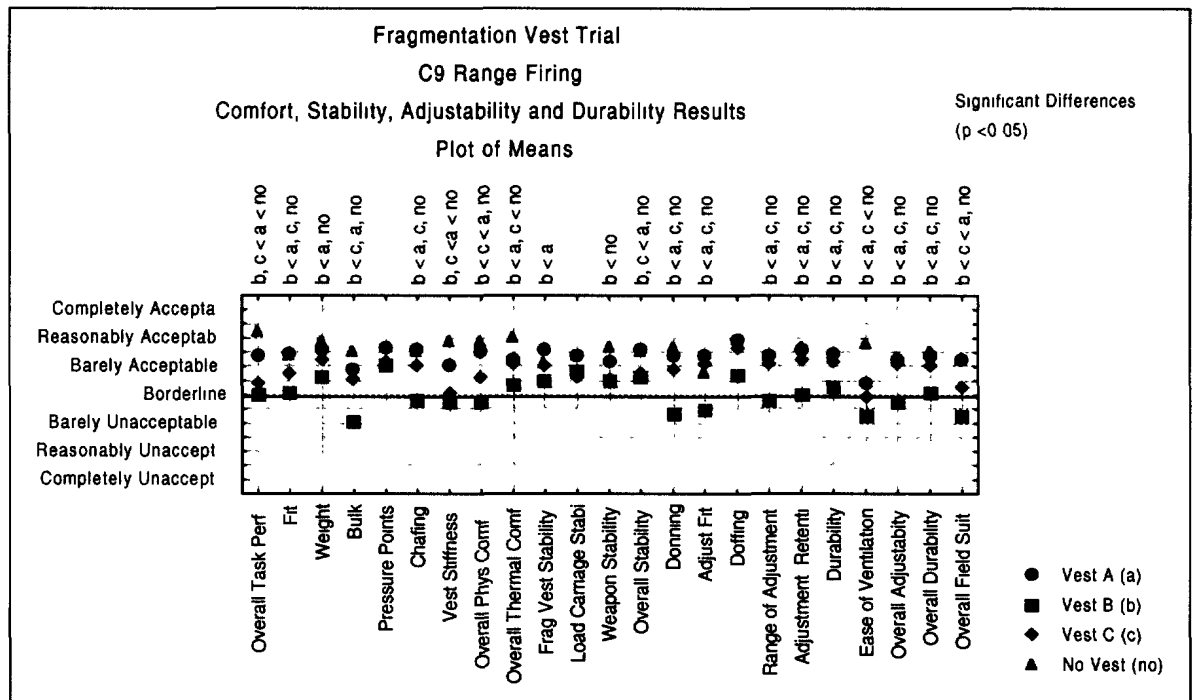


Figure 8: C9 LMG Task Questionnaire Results (Questions 18-41)

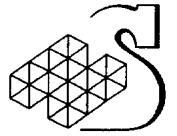
Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vests B and C for Overall C9 LMG firing, Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Barely to Reasonably Acceptable*). Vest A was also rated acceptable for Overall Compatibility and Overall Task Performance (*Borderline to Barely Acceptable*). Some concerns with weapon butt plate positioning were noted with Vest A.

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for Overall Rifle Firing Performance, Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Unacceptable*). Participants noted problems with vest bulk, excessive vest length, neck discomfort, and shoulder pad placement.

Vest C: Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A for Overall C9 LMG Firing Performance (*Borderline to Barely Unacceptable*). Vest C was also rated acceptable for Overall Compatibility, Overall Task Performance and Suitability for Field Use (*Borderline to Barely Acceptable*).

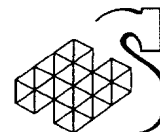
4. Discussion

For all combat activities tested, Vest B was rated as the least acceptable vest and for many range firing activities, Vest B was rated as being unacceptable. Vest A was rated the most acceptable vest for most of the combat activity tasks. Perceived vest performance in the combat activities appeared to be most affected by vest bulk, loss of range of motion, compatibility with equipment and weapons and inadvertent snagging.



**Appendix 1 to Annex I:
Range Firing**

**APPENDIX 1 TO ANNEX I:
C7A1 Range Firing Serial**

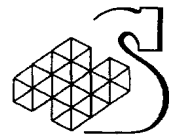


C7A1 Firing Tests

Ser	Practice	Target	Range (m)	Rounds	Position	Scoring*
8a	Fire and movement	NA	400	0	Prep stage –firer in prone position with 2 magazines with 14 rd mag loaded, observe target area	NA
8b		Fig 11 in target frame	300	6	When tgt appears at 400m firer runs to 300 m and engages tgt from prone position	1 pt per hit
8c		Fig 11 in target frame	200	8	When tgt reappears at 300m firer runs to 200 m and engages tgt from kneeling position	1 pt per hit
8d		Fig 11 in target frame	100	8	When tgt reappears at 200m firer runs to 100 m and engages tgt from kneeling position	1 pt per hit
8e		Fig 11 in target frame	100	2	When tgt reappears at 100m firer engages tgt from kneeling position	1 pt per hit
8f		Fig 11 on stick	75	2	When tgt reappears at 100m firer runs to 75 m and engages tgt from standing position	1 pt per hit
8g		Fig 11 on stick	50	2	When tgt reappears at 75m firer runs to 50 m and engages tgt from standing position	1 pt per hit
8h		Fig 11 on stick	25	6	When tgt reappears at 50m firer runs to 25 m and engages tgt from standing position using rapid fire	1 pt per hit

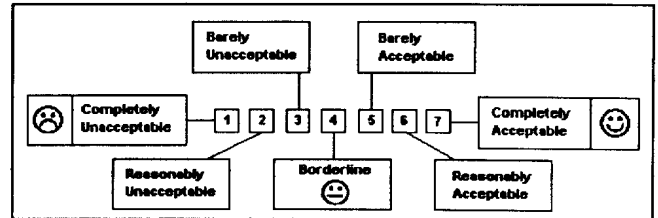
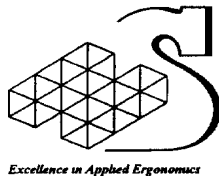
*Note: Highest possible score for serials 8a – 8h = 34

Table 1: Fire and Movement Test



**Appendix 2 to Annex I:
Range Firing**

**APPENDIX 2 TO ANNEX I:
C7A1 Range Firing Task Questionnaire**

**PERSONAL DATA**

Clearly print your Name, Subject Number and Vest Type in the boxes provided.

NAME

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SUBJECT NUMBER

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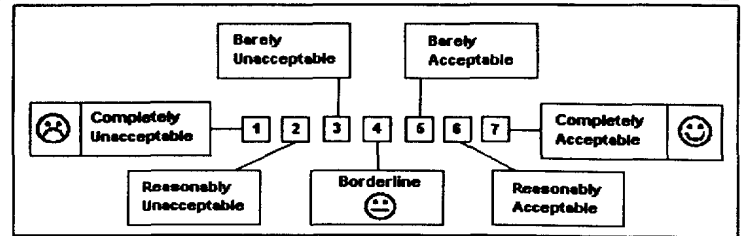
FRAGMENTATION VEST TYPE: None: ☐ Vest A: ☐ Vest B: ☐ Vest C: ☐

FRAG VEST NUMBER: _____

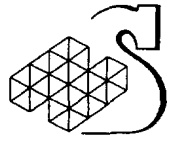
LOAD CARRIAGE TYPE: 82 Pattern Webbing: ☐ TAV: ☐**DIRECTIONS:**

Please provide a rating of acceptance for ease of fire and movement, compatibility, comfort, stability, adjustability and overall acceptance, using the 7-point scale above, for the acceptability to perform C9 familiarization firing drills.

COMMENTS:

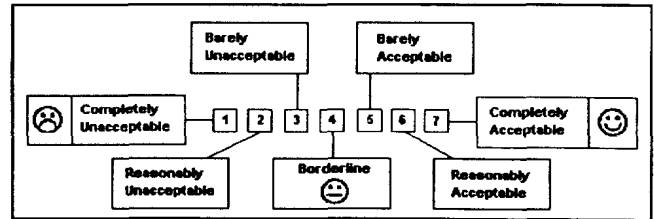
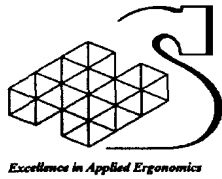
**C7 FIRING TASK:**

Ease of Operation	☹ 1 2 3 4 5 6 7 ☺	Comfort	☹ 1 2 3 4 5 6 7 ☺
Movement	○ ○ ○ ○ ○ ○ ○ ○	Fit	○ ○ ○ ○ ○ ○ ○ ○
Dropping to prone position	○ ○ ○ ○ ○ ○ ○ ○	Weight	○ ○ ○ ○ ○ ○ ○ ○
Adopting prone fire position	○ ○ ○ ○ ○ ○ ○ ○	Bulk	○ ○ ○ ○ ○ ○ ○ ○
Sighting	○ ○ ○ ○ ○ ○ ○ ○	Pressure Points	○ ○ ○ ○ ○ ○ ○ ○
Firing	○ ○ ○ ○ ○ ○ ○ ○	Chaffing	○ ○ ○ ○ ○ ○ ○ ○
Loading/Unloading	○ ○ ○ ○ ○ ○ ○ ○	Vest stiffness	○ ○ ○ ○ ○ ○ ○ ○
Accessing ammunition in LC	○ ○ ○ ○ ○ ○ ○ ○	Overall Physical Comfort	○ ○ ○ ○ ○ ○ ○ ○
Standing up	○ ○ ○ ○ ○ ○ ○ ○	Overall Thermal Comfort	○ ○ ○ ○ ○ ○ ○ ○
Accessing belts	○ ○ ○ ○ ○ ○ ○ ○	Stability	☹ ☺ ☺ ☺ ☺ ☺ ☺
Standing up	○ ○ ○ ○ ○ ○ ○ ○	Fragmentation Vest Stability	○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○	Load Carriage Stability	○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○	Weapon Stability	○ ○ ○ ○ ○ ○ ○ ○
Overall C7 Firing Task	○ ○ ○ ○ ○ ○ ○ ○	Overall Stability	○ ○ ○ ○ ○ ○ ○ ○
Compatibility	☹ ☺ ☺ ☺ ☺ ☺ ☺	Adjustment/Durability	☹ ☺ ☺ ☺ ☺ ☺ ☺
Load Carriage	○ ○ ○ ○ ○ ○ ○ ○	Put On	○ ○ ○ ○ ○ ○ ○ ○
Helmets	○ ○ ○ ○ ○ ○ ○ ○	Adjust Fit	○ ○ ○ ○ ○ ○ ○ ○
Clothing	○ ○ ○ ○ ○ ○ ○ ○	Take Off	○ ○ ○ ○ ○ ○ ○ ○
Gloves	○ ○ ○ ○ ○ ○ ○ ○	Range of Adjustments	○ ○ ○ ○ ○ ○ ○ ○
Weapons	○ ○ ○ ○ ○ ○ ○ ○	Adjustment Retention	○ ○ ○ ○ ○ ○ ○ ○
Snagging	○ ○ ○ ○ ○ ○ ○ ○	Durability	○ ○ ○ ○ ○ ○ ○ ○
Overall Compatibility	○ ○ ○ ○ ○ ○ ○ ○	Ease of Ventilation	○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○	Overall Adjustability	○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○	Overall Durability	○ ○ ○ ○ ○ ○ ○ ○
Overall Task Performance	○ ○ ○ ○ ○ ○ ○ ○	Overall Suitability for Field Use	○ ○ ○ ○ ○ ○ ○ ○



**Appendix 3 to Annex I:
Range Firing**

**APPENDIX 3 TO ANNEX I:
C9 Range Firing Task Questionnaire**

**PERSONAL DATA**

Clearly print your Name, Subject Number and Vest Type in the boxes provided.

NAME

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SUBJECT NUMBER

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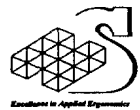
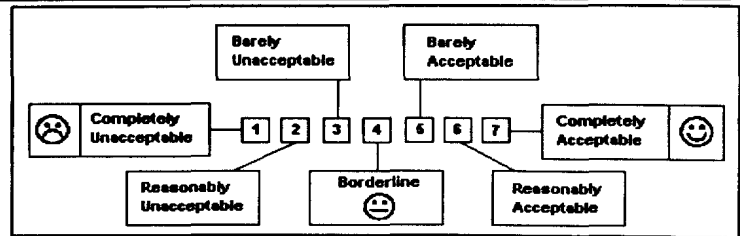
FRAGMENTATION VEST TYPE: None: ☐ Vest A: ☐ Vest B: ☐ Vest C: ☐

FRAG VEST NUMBER: _____

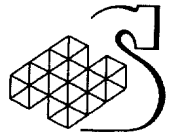
LOAD CARRIAGE TYPE: 82 Pattern Webbing: ☐ TAV: ☐**DIRECTIONS**

Please provide a rating of acceptance for ease of fire and movement, compatibility, comfort, stability, adjustability and overall acceptance, using the 7-point scale above, for the acceptability to perform C9 familiarization firing drills.

COMMENTS

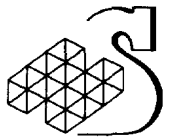
**C9 FIRING TASK:**

Ease of Operation	☹ 1 2 3 4 5 6 7 ☺	Comfort	☹ 1 2 3 4 5 6 7 ☺
Movement	○ ○ ○ ○ ○ ○ ○	Fit	○ ○ ○ ○ ○ ○ ○
Dropping to prone position	○ ○ ○ ○ ○ ○ ○	Weight	○ ○ ○ ○ ○ ○ ○
Adopting prone fire position	○ ○ ○ ○ ○ ○ ○	Bulk	○ ○ ○ ○ ○ ○ ○
Sighting	○ ○ ○ ○ ○ ○ ○	Pressure Points	○ ○ ○ ○ ○ ○ ○
Firing	○ ○ ○ ○ ○ ○ ○	Chaffing	○ ○ ○ ○ ○ ○ ○
Loading/Unloading	○ ○ ○ ○ ○ ○ ○	Vest stiffness	○ ○ ○ ○ ○ ○ ○
Accessing ammunition in LC	○ ○ ○ ○ ○ ○ ○	Overall Physical Comfort	○ ○ ○ ○ ○ ○ ○
Standing up	○ ○ ○ ○ ○ ○ ○	Overall Thermal Comfort	○ ○ ○ ○ ○ ○ ○
Accessing belts	○ ○ ○ ○ ○ ○ ○	Stability	☹ ☺ ☺ ☺ ☺ ☺ ☺
Standing up	○ ○ ○ ○ ○ ○ ○	Fragmentation Vest Stability	○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○	Load Carriage Stability	○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○	Weapon Stability	○ ○ ○ ○ ○ ○ ○
Overall C9 Firing Task	○ ○ ○ ○ ○ ○ ○	Overall Stability	○ ○ ○ ○ ○ ○ ○
Compatibility	☹ ☺ ☺ ☺ ☺ ☺ ☺	Adjustment/Durability	☹ ☺ ☺ ☺ ☺ ☺ ☺
Load Carriage	○ ○ ○ ○ ○ ○ ○	Put On	○ ○ ○ ○ ○ ○ ○
Helmets	○ ○ ○ ○ ○ ○ ○	Adjust Fit	○ ○ ○ ○ ○ ○ ○
Clothing	○ ○ ○ ○ ○ ○ ○	Take Off	○ ○ ○ ○ ○ ○ ○
Gloves	○ ○ ○ ○ ○ ○ ○	Range of Adjustments	○ ○ ○ ○ ○ ○ ○
Weapons	○ ○ ○ ○ ○ ○ ○	Adjustment Retention	○ ○ ○ ○ ○ ○ ○
Snagging	○ ○ ○ ○ ○ ○ ○	Durability	○ ○ ○ ○ ○ ○ ○
Overall Compatibility	○ ○ ○ ○ ○ ○ ○	Ease of Ventilation	○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○	Overall Adjustability	○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○	Overall Durability	○ ○ ○ ○ ○ ○ ○
Overall Task Performance	○ ○ ○ ○ ○ ○ ○	Overall Suitability for Field Use	○ ○ ○ ○ ○ ○ ○



**Annex J:
Battle Tasks**

**ANNEX J:
Battle Tasks**



Annex J: Battle Tasks

1. Introduction

Participants performed two battle tasks (section fire and movement and FIBUA house clearing) to evaluate the effect of the different vests on perceived fighting effectiveness during realistic simulations of combat operations. Participants were divided into three sections consisting of a Section Commander who was a non-participant trial NCO, six riflemen and two C9 gunners. Previously, all the participants had observed a fire & movement and a house clearing demonstration and then had practiced the tactical drills. The battle tasks were performed in a tactical setting as a platoon organization.

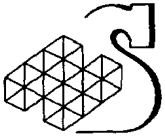
2. Method

2.1. Fire and Movement

The fire and movement task was performed in open ground in the training areas at CFB Petawawa adjacent to the FIBUA site. The drill involved the platoon advancing along a trail and upon entering a clearing was engaged by a separate enemy force. Upon contact the lead two sections cleared the forward two enemy trenches while the depth section cleared the enemy's depth trench. Upon completion of the Section attack and FIBUA assault the participants completed a Task Questionnaire.



Figure1: Participant Engaging in Fire and Movement



Annex J: Battle Tasks

2.2. House Clearing

Upon the completion of the fire and movement section attack phase of the battle task, the depth section then provided a fire-base for the one-story building's entry at the nearby FIBUA training complex. Once the first building was secure the platoon broke into the second two story building and cleared it by leapfrogging sections forward. An active enemy force was provided by trial support staff. The participants utilized mouse holes in the walls and ceilings (with ropes) to move through the two-story building. Upon completion of the Section attack and FIBUA assault, the participants completed the Task Questionnaire.

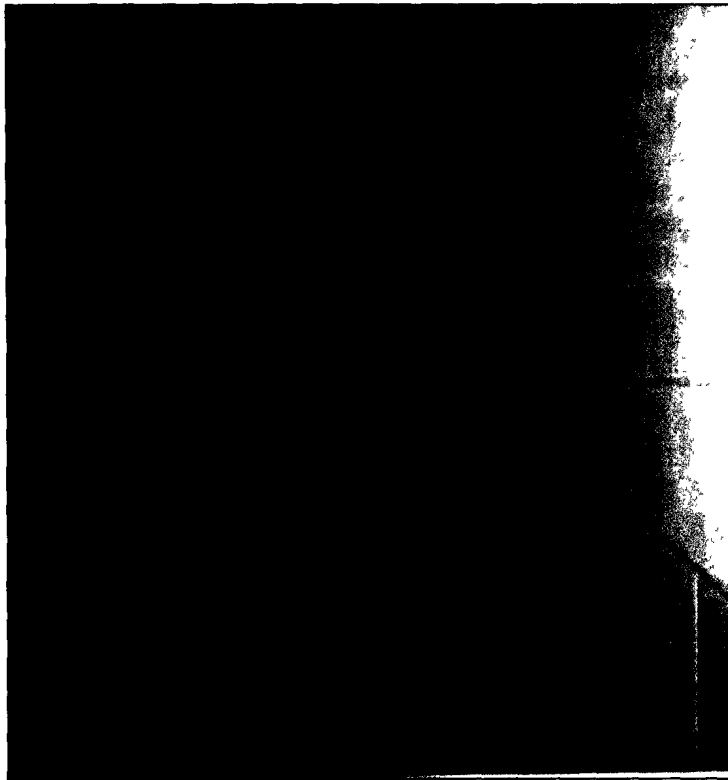
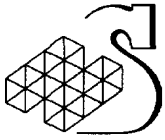


Figure 2: Participant Scaling a Ceiling Mouse Hole



Annex J: Battle Tasks

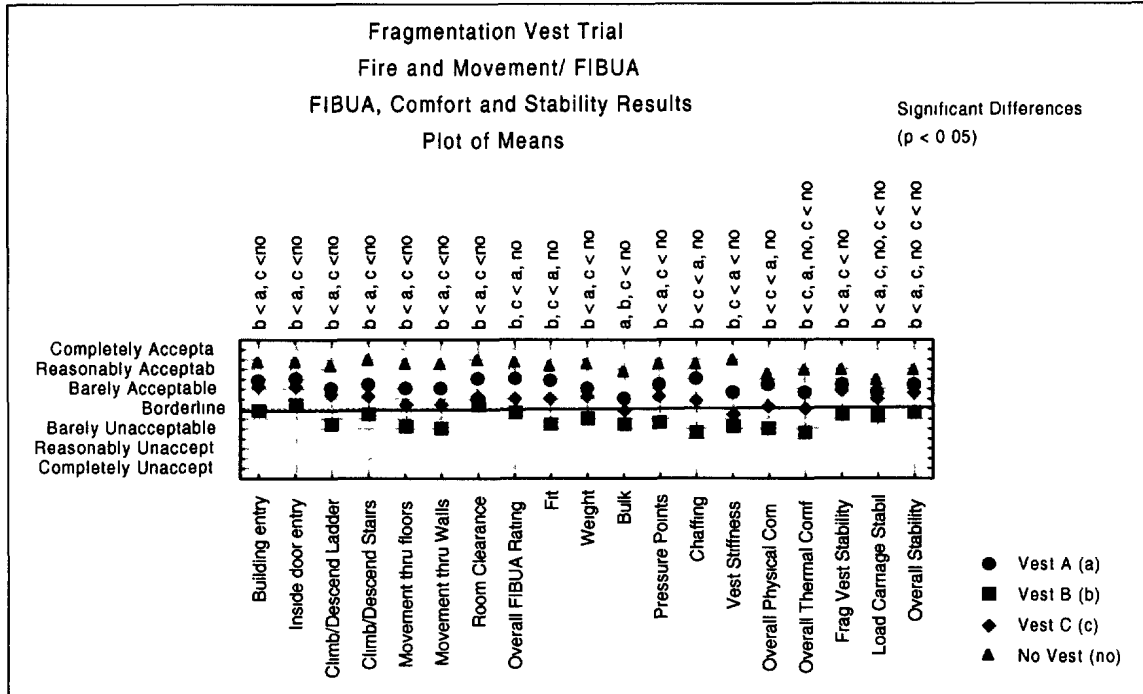


Figure 5: Fire and Movement/FIBUA Task Questionnaire Results (Questions 19-37)

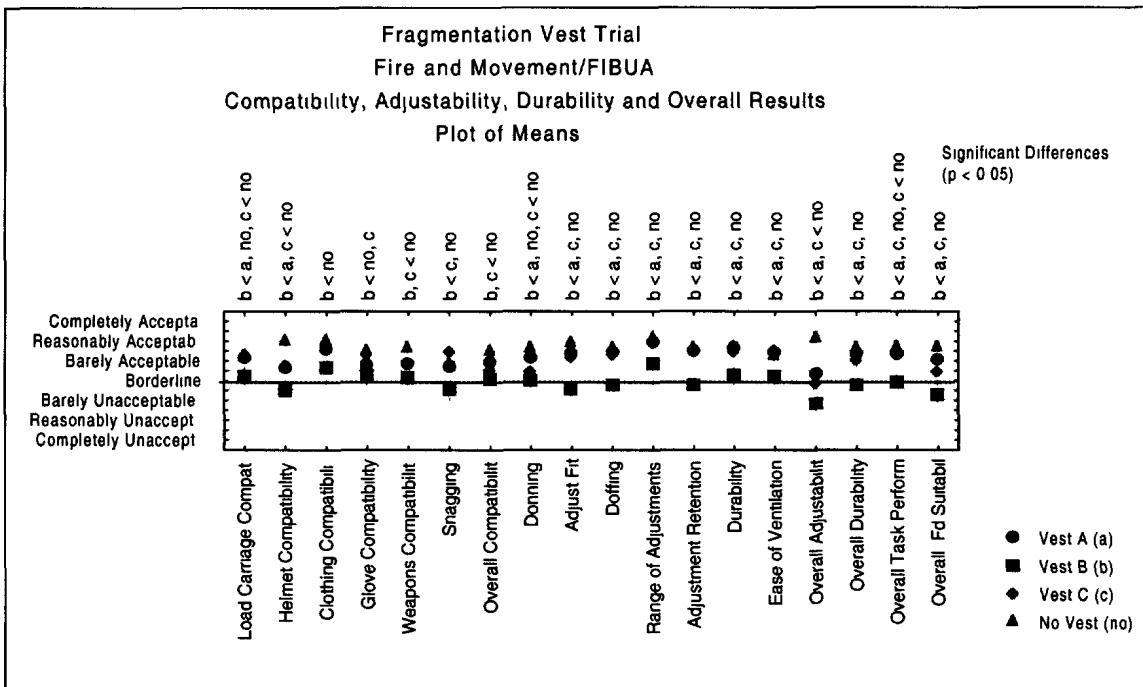
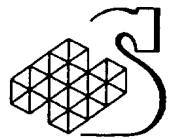


Figure 6: Fire and Movement/FIBUA Task Questionnaire Results (Questions 38-55)



Annex J: Battle Tasks

For the combined battle task, Vests A (*Barely to Reasonably Acceptable*) and Vest C (*Borderline to Barely Acceptable*) were rated as being acceptable. Vest B was rated as being unacceptable for the overall battle task (*Borderline to Barely Unacceptable*). Overall, Vest B was rated as being significantly ($p < 0.05$) less acceptable than Vests A and C for the battle tasks. Vests A and C were also rated as being significantly ($p < 0.05$) less acceptable than the No Vest condition for the battle task. Vest B was rated as being unacceptable for Field Use (*Borderline to Barely Unacceptable*) and was significantly less acceptable than Vests A and C. Separate Battle Task Phase results are summarized below:

3.1. Fire and Movement

The fire and movement tasks involved sections performing Group, Team and individual fire and movement. Results for each vest condition are described below.

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vests B for Overall Manoeuvrability and Fire & Movement (*Barely to Reasonably Acceptable*). Except for speed of movement, Vest A was also rated significantly ($p < 0.05$) more acceptable than Vest B for all unique fire and movement questions (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for Overall Manoeuvrability and Fire & Movement (*Borderline to Barely Unacceptable*). Except for speed of movement and accessing magazines, Vest B was also rated significantly ($p < 0.05$) less acceptable than Vests A and C for all unique fire and movement questions (*Barely Acceptable to Barely Unacceptable*).

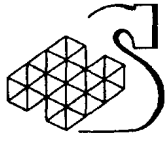
Vest C: Vest C was rated significantly ($p < 0.05$) more acceptable than Vests B for Overall Manoeuvrability and Fire & Movement (*Barely to Reasonably Acceptable*). Except for accessing magazines, Vest C was also rated significantly ($p < 0.05$) more acceptable than Vest B for all unique fire and movement questions (*Barely to Reasonably Acceptable*).

3.2. House Clearing

Upon the completion of the fire and movement section attack phase of the battle task, the depth section then provided a fire-base for the one-story building's entry at the nearby FIBUA training complex. Once the first building was secure the platoon broke into the second two-story building and cleared it using proper room clearing techniques. The participants utilized mouse holes in the walls and ceilings (with ropes) to move through the two-story building. Results for each vest condition are described below.

Vest A: Vest A was rated significantly ($p < 0.05$) more acceptable than Vests B for Overall Stability and Suitability for FIBUA operations (*Barely to Reasonably Acceptable*). Except for bulk, Vest A was also rated significantly ($p < 0.05$) more acceptable than Vest B for all FIBUA questions (*Barely to Reasonably Acceptable*).

Vest B: Vest B was rated significantly ($p < 0.05$) less acceptable than Vests A and C for Stability and significantly ($p < 0.05$) less acceptable than Vest A for FIBUA operations (*Borderline to Barely Unacceptable*). Except for vest fit, bulk, stiffness Vest B was also rated



Annex J: Battle Tasks

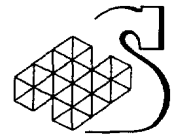
significantly ($p < 0.05$) less acceptable than Vests A and C for all unique FIBUA questions (*Barely Acceptable to Reasonably Unacceptable*).

Vest C: Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A for Overall FIBUA ratings, fit, and vest stiffness (*Borderline to Barely Acceptable*). Vest C was rated significantly ($p < 0.05$) more acceptable than Vest B for Stability (*Borderline to Barely Acceptable*). Except for vest fit, bulk, and stiffness, Vest C was also rated significantly ($p < 0.05$) more acceptable than Vest B for all other FIBUA questions (*Barely to Reasonably Acceptable*).

4. Discussion

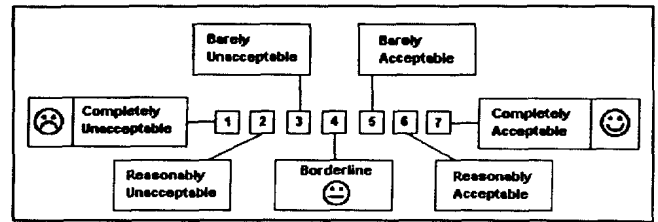
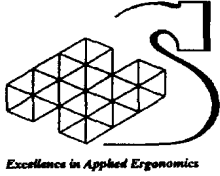
For the combined Battle task serials, Vest B was assessed as the least acceptable vest and for many activities, Vest B was rated as being unacceptable. Vest A was rated the most acceptable vest for most combat activity criteria. Perceived vest performance in battle tasks appeared to be most affected by vest bulk, loss of range of motion, compatibility with equipment and weapons, comfort, adjustability and inadvertent snagging.

Post-hoc analysis between the results of all subjects and just the infantry participants for the Battle task Questionnaire did not indicate any overall significant differences between subject groups. Similarly, a post-hoc analysis between the results of all subjects and just the female subjects did not indicate any overall significant differences between subject groups.



**Appendix 1 to Annex J:
Battle Tasks**

**APPENDIX 1 TO ANNEX J:
Battle Task Questionnaire**

**PERSONAL DATA**

Clearly print your Name, Subject Number and Vest Type in the boxes provided.

NAME

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SUBJECT NUMBER

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Fire and Movement Task Serial _____

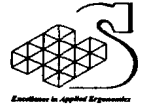
FRAGMENTATION VEST TYPE: None: ☐ Vest A: ☐ Vest B: ☐ Vest C: ☐

FRAG VEST NUMBER: _____

LOAD CARRIAGE TYPE: 82 Pattern Webbing: ☐ TAV: ☐**DIRECTIONS**

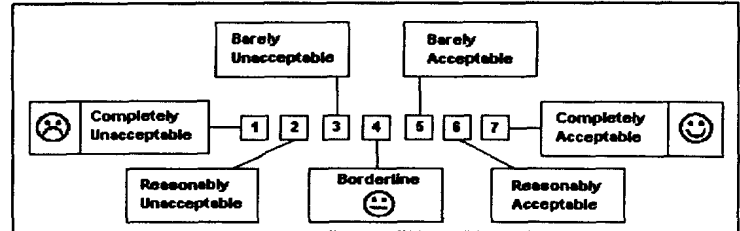
Please provide a rating of acceptance for manoeuvrability, ease of fire and movement, ease of FIBUA assault, compatibility, comfort, stability, adjustability and overall acceptance, using the 7-point scale above, for the acceptability to perform combat assault drills.

COMMENTS



FIRE AND MOVEMENT /

FIBUA TASK:

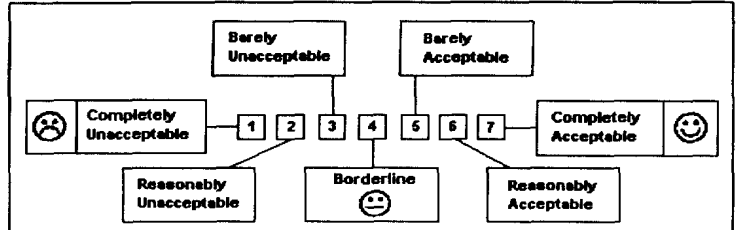


Manoeuvrability	⊗ 1 2 3 4 5 6 7 ☺	Ease of FIBUA Assault	⊗ 1 2 3 4 5 6 7 ☺
Speed of Movement	○ ○ ○ ○ ○ ○ ○ ○	Building entry	○ ○ ○ ○ ○ ○ ○ ○
Agility	○ ○ ○ ○ ○ ○ ○ ○	Inside door entry	○ ○ ○ ○ ○ ○ ○ ○
Flexibility	○ ○ ○ ○ ○ ○ ○ ○	Climbing/descending ladders	○ ○ ○ ○ ○ ○ ○ ○
Overall Manoeuvrability	○ ○ ○ ○ ○ ○ ○ ○	Climbing/descending stairs	○ ○ ○ ○ ○ ○ ○ ○
Ease of Fire and Movement	⊗ 1 2 3 4 5 6 7 ☺	Passage up/down through floor/ceiling mouse holes	○ ○ ○ ○ ○ ○ ○ ○
Running	○ ○ ○ ○ ○ ○ ○ ○	Passage through wall mouse holes	○ ○ ○ ○ ○ ○ ○ ○
Dropping to prone position	○ ○ ○ ○ ○ ○ ○ ○	Room clearance	○ ○ ○ ○ ○ ○ ○ ○
Crouching	○ ○ ○ ○ ○ ○ ○ ○	Overall FIBUA Task	○ ○ ○ ○ ○ ○ ○ ○
Crawling	○ ○ ○ ○ ○ ○ ○ ○	Comfort	⊗ ☺ ☺
Adopting prone fire position	○ ○ ○ ○ ○ ○ ○ ○	Fit	○ ○ ○ ○ ○ ○ ○ ○
Adopting kneeling fire position	○ ○ ○ ○ ○ ○ ○ ○	Weight	○ ○ ○ ○ ○ ○ ○ ○
Adopting standing fire position	○ ○ ○ ○ ○ ○ ○ ○	Bulk	○ ○ ○ ○ ○ ○ ○ ○
Sighting	○ ○ ○ ○ ○ ○ ○ ○	Pressure points	○ ○ ○ ○ ○ ○ ○ ○
Firing	○ ○ ○ ○ ○ ○ ○ ○	Chaffing	○ ○ ○ ○ ○ ○ ○ ○
Loading/Unloading	○ ○ ○ ○ ○ ○ ○ ○	Vest stiffness	○ ○ ○ ○ ○ ○ ○ ○
Accessing mags/grenades	○ ○ ○ ○ ○ ○ ○ ○	Overall Physical Comfort	○ ○ ○ ○ ○ ○ ○ ○
Throwing grenades	○ ○ ○ ○ ○ ○ ○ ○	Overall Thermal Comfort	○ ○ ○ ○ ○ ○ ○ ○
Standing up	○ ○ ○ ○ ○ ○ ○ ○	Stability	⊗ ☺ ☺
	○ ○ ○ ○ ○ ○ ○ ○	Fragmentation Vest Stability	○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○	Load Carriage Stability	○ ○ ○ ○ ○ ○ ○ ○
Overall Fire and Movement Task	○ ○ ○ ○ ○ ○ ○ ○	Overall Stability	○ ○ ○ ○ ○ ○ ○ ○

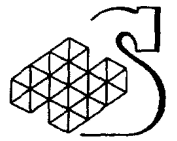


FIRE AND MOVEMENT /

FIBUA TASK:



Compatibility	☹ ☺ ☺ ☺ ☺ ☺ ☺ ☺	Adjustment/Durability	☹ ☺ ☺ ☺ ☺ ☺ ☺ ☺
Load Carriage	○ ○ ○ ○ ○ ○ ○ ○	Put On	○ ○ ○ ○ ○ ○ ○ ○
Helmet	○ ○ ○ ○ ○ ○ ○ ○	Adjust Fit	○ ○ ○ ○ ○ ○ ○ ○
Clothing	○ ○ ○ ○ ○ ○ ○ ○	Take Off	○ ○ ○ ○ ○ ○ ○ ○
Gloves	○ ○ ○ ○ ○ ○ ○ ○	Range of Adjustments	○ ○ ○ ○ ○ ○ ○ ○
Weapons	○ ○ ○ ○ ○ ○ ○ ○	Adjustment Retention	○ ○ ○ ○ ○ ○ ○ ○
Snagging	○ ○ ○ ○ ○ ○ ○ ○	Durability	○ ○ ○ ○ ○ ○ ○ ○
Overall Compatibility	○ ○ ○ ○ ○ ○ ○ ○	Ease of Ventilation	○ ○ ○ ○ ○ ○ ○ ○
	☹ ☺ ☺ ☺ ☺ ☺ ☺ ☺	Overall Adjustability	○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○	Overall Durability	○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○		○ ○ ○ ○ ○ ○ ○ ○
	○ ○ ○ ○ ○ ○ ○ ○		○ ○ ○ ○ ○ ○ ○ ○
Overall Task Performance	○ ○ ○ ○ ○ ○ ○ ○	Overall Suitability for Field Use	○ ○ ○ ○ ○ ○ ○ ○



**Annex K:
Comfort**

ANNEX K:

Comfort



1. Introduction

Physical and thermal discomfort were evaluated following the C7 Range run down serials and after the section fire and movement and FIBUA assault serials.

2. Method

Following each set of range firing serials, participants completed a set of Physical and Thermal discomfort questionnaires. Upon completion of the Section attack and FIBUA assault the participants also completed a second set of Physical and Thermal Discomfort Questionnaires.

2.1. Thermal Discomfort

This questionnaire was comprised of two drawings depicting the front and back views of the torso. Participants were required to indicate the location of any heat build-up and rate the amount of thermal discomfort using the five point rating scale provided – see Appendix 1.

2.2. Physical Discomfort:

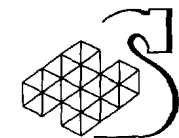
This questionnaire was comprised of two drawings depicting the front and back views of the torso. Participants were required to indicate the body location and rate the extent of physical discomfort using the five point rating scale provided – see Appendix 2. Discomfort could include, but was not limited to, contact irritation or pressure points.

3. Results

After the C7A1 run down serials and the fire and movement serials, the participants completed both a Physical and Thermal Comfort Questionnaire. It should be noted that the trial was conducted in typical autumn weather with cool, overcast conditions. While the tasks were short in duration – approximately 45 minutes long, they were physically demanding. Combined task results for physical and thermal discomfort are reported separately below.

3.1. Physical Comfort

Mean ratings for Physical Discomfort for all participants are summarized below (Figures 1 and 2) for each vest in the front and back of the body. Significant ($p < 0.05$) differences are indicated where appropriate.



**Annex K:
Comfort**

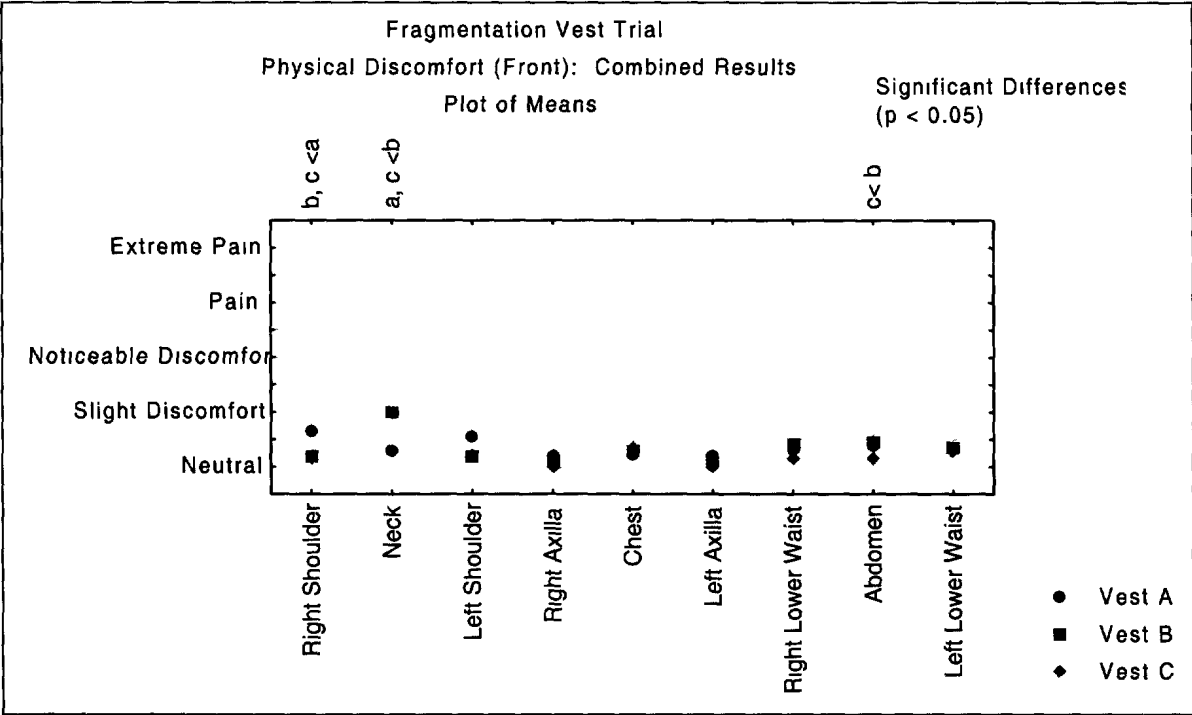


Figure 1: Physical Discomfort Results (Front)

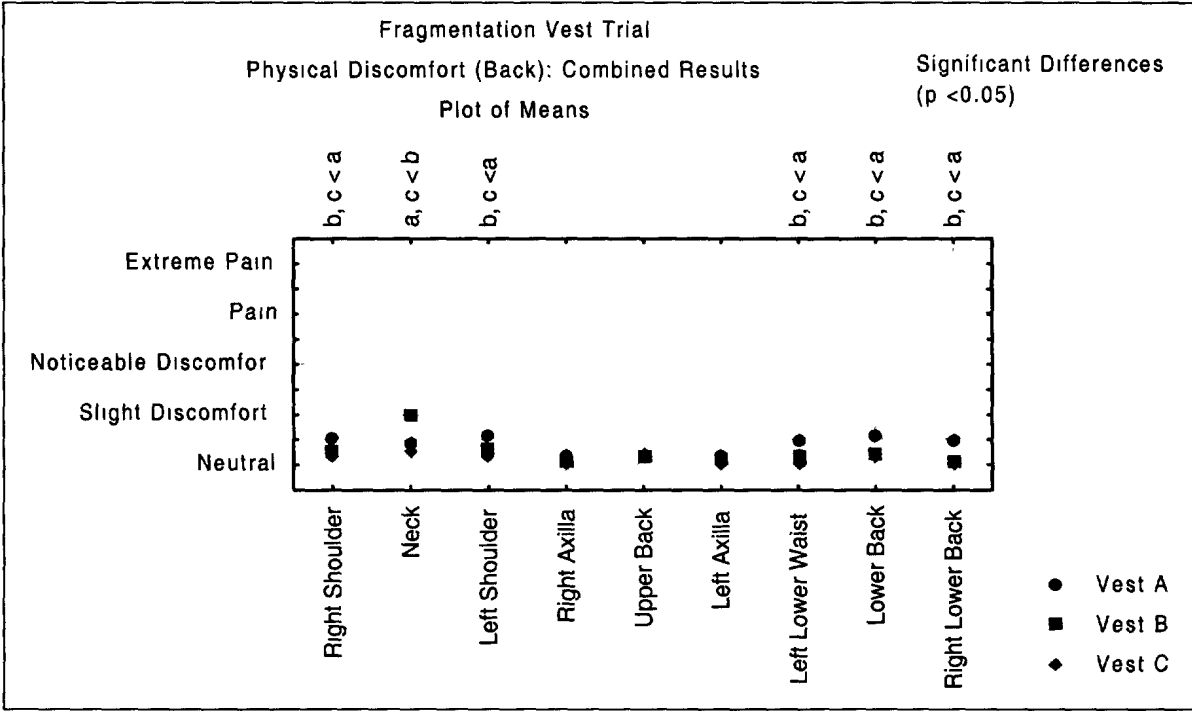


Figure 2: Physical Discomfort Results (Back)

Front: Shoulder and neck discomfort were the most commonly reported problems with all three vests. Vest A evidenced significantly ($p < 0.05$) higher shoulder discomfort than Vest B (Right Shoulder) and Vest C (Right and Left Shoulders). Vest B evidenced significantly ($p < 0.05$) higher neck discomfort (Slight Discomfort) than Vests A and C. Vests A and B were rated as having significantly ($p < 0.05$) more Abdomen discomfort as compared to Vest C. Except for Vest B's neck discomfort rating, the discomfort levels reported with any Vest were between none and only slight. Discomfort differences between right and left shoulders may be due to the effects of rifle firing.

Back: Vest B evidenced significantly ($p < 0.05$) higher neck discomfort (Slight Discomfort) than Vests A and C. Vests A was rated as having significantly ($p < 0.05$) more Abdomen discomfort as compared to Vests B and C. Except for Vest B's neck discomfort rating, the discomfort levels reported with any Vest were between none and only slight.

3.2. Thermal Comfort

Mean ratings for Thermal Discomfort for all participants are summarized below in Figures 3 and 4 for each vest (front and back of the body). Significant ($p < 0.05$) differences are indicated where appropriate.

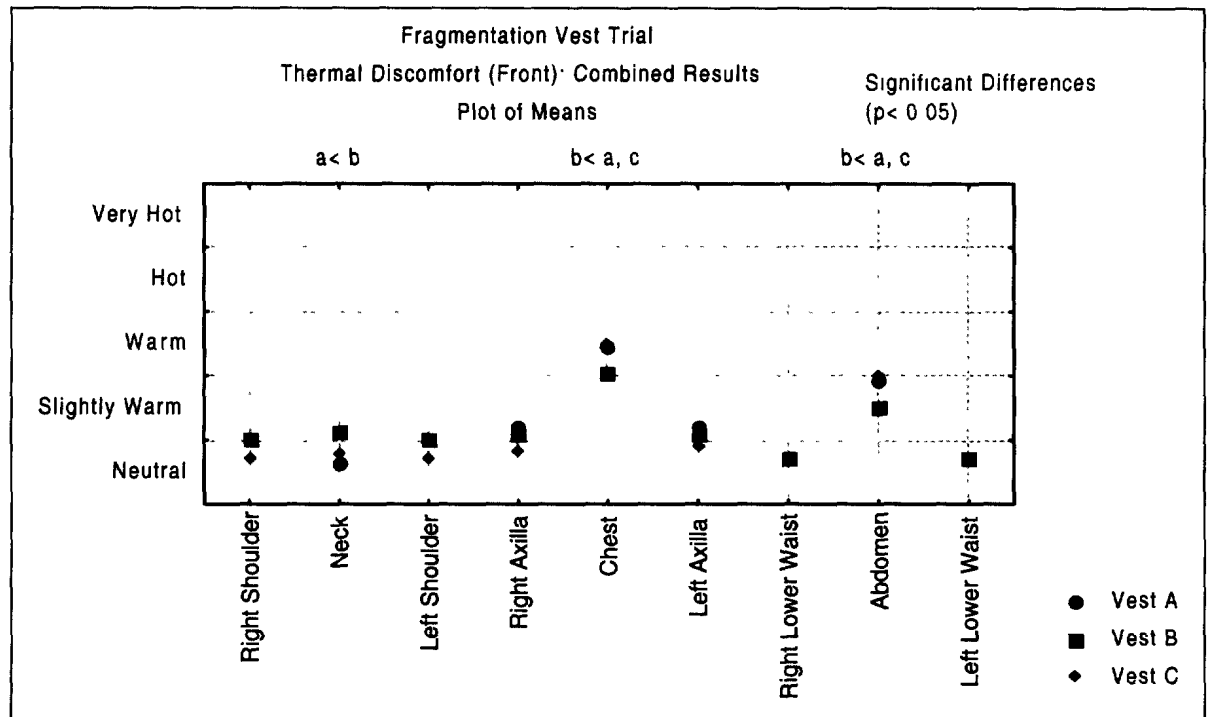


Figure 3: Thermal Discomfort Results (Front)



Annex K: Comfort

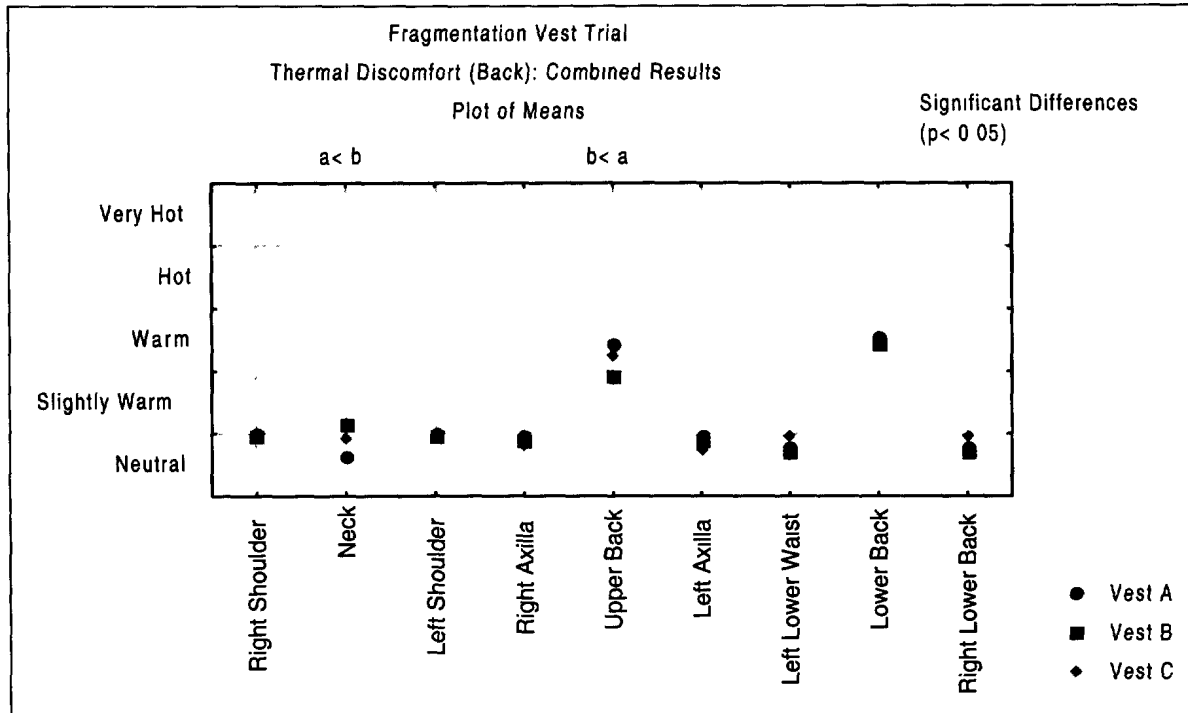


Figure 4: Thermal Discomfort Results (Back)

Front: Chest thermal discomfort was reported by most of the participants for all three vests (*Slightly Warm to Warm*). Next to the chest region, the abdomen suffered the next highest percentage of discomfort (*Neutral to Slightly Warm*). There were significant differences between Vest A and C for the thermal comfort associated with the right and left shoulder.

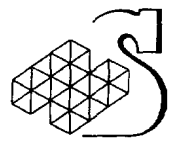
Back: Lower and upper back thermal discomfort was reported by most participants for all three vests at similarly moderate levels of thermal stress (*Slightly Warm to Warm*).

There were no significant differences between vests for regions of thermal discomfort. It should be noted again that the weather conditions during the trial were cool and overcast and thus the thermal discomfort results may not be indicative of results to be expected in warmer temperatures.

4. Discussion

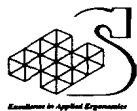
The shoulders, neck, and upper and lower torso regions were the most commonly reported areas of physical discomfort for all three vests. While the physical discomfort ratings were generally low, the discomfort associated with Vest B's neck design was notable. The design promotes chaffing and skin irritation. Given the fact that the trial tasks were only of short duration the resulting physical discomfort could be significantly higher after a period of continuous wear, i.e. 8 hours.

All of the subjects reported that the vests were hot. The form fitting design of Vests A and C caused higher ratings of thermal stress than the looser fit of Vest B. The larger design of Vest B may have caused forced ventilation due to pumping effects, thus making Vest B's chest and waist to be perceived as being cooler. The participants commented that unlike Vest B, Vests A and C allowed them to loosen off their side straps to permit increased ventilation.



**Appendix 1 to Annex K:
Comfort**

**APPENDIX 1 TO ANNEX K:
Thermal Comfort Questionnaire**



THERMAL COMFORT

PERSONAL DATA

Clearly indicate your Name, Subject Number and Vest Type.

NAME

--	--	--	--	--	--	--	--	--	--	--	--

SUBJECT NUMBER

--	--

TASK

FRAGMENTATION VEST TYPE:

None: ☐

Vest A: ☐

Vest B: ☐

Vest C: ☐

FRAG VEST NUMBER: _____

CERAMIC PLATES:

YES: ☐

NO: ☐

LOAD CARRIAGE TYPE:

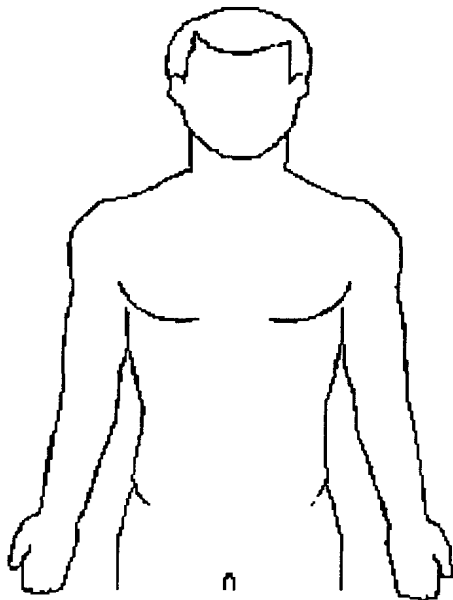
82 Pattern Webbing: ☐

TAV: ☐

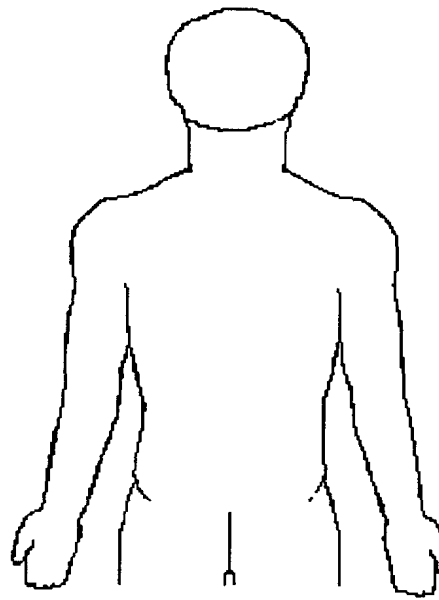
Using the different views of the torso below, draw in the areas where you feel warm or hot. Indicate how warm or hot by assigning a number from the scale to the right.

Neutral	Slightly Warm	Warm	Hot	Very Hot
1	2	3	4	5

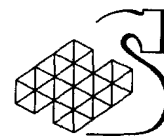
FRONT



BACK

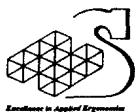


COMMENTS:



**Appendix 2 to Annex K:
Comfort**

**APPENDIX 2 TO ANNEX K:
Physical Comfort Questionnaire**



PHYSICAL COMFORT

PERSONAL DATA

Clearly indicate your Name, Subject Number and Vest Type.

NAME

--	--	--	--	--	--	--	--	--	--	--	--

SUBJECT NUMBER

--	--

TASK

FRAGMENTATION VEST TYPE:

None: ☐

Vest A: ☐

Vest B: ☐

Vest C: ☐

FRAG VEST NUMBER:

CERAMIC PLATES:

YES: ☐

NO: ☐

LOAD CARRIAGE TYPE:

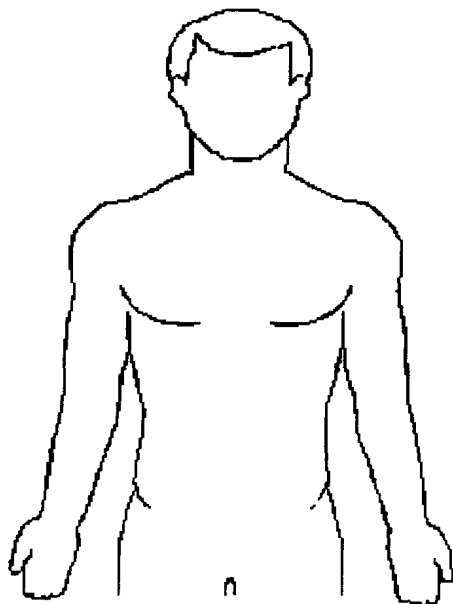
82 Pattern Webbing: ☐

TAV: ☐

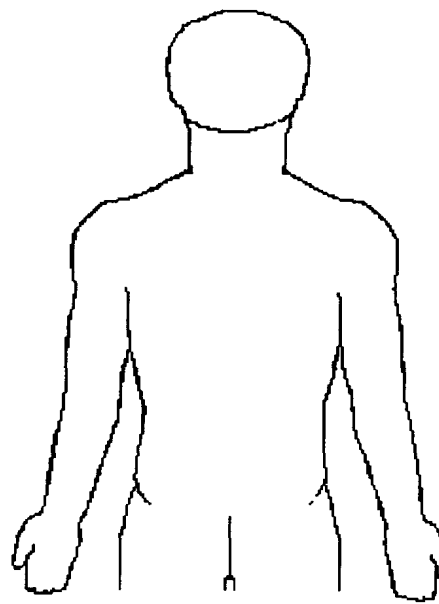
Using the different views of the torso below, draw in the areas where you feel discomfort. Indicate how much discomfort with a number from the scale to the right.

Neutral	Slight Discomfort	Noticeable Discomfort	Pain	Extreme Pain
1	2	3	4	5

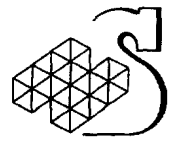
FRONT



BACK

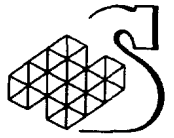


COMMENTS:



**Annex L:
Exit Focus Group**

**ANNEX L:
Exit Focus Group**



Annex L: Exit Focus Group

1. Introduction

A focus group was held at the completion of the trial to allow a direct comparison of all three fragmentation vests, rate individual vest features, rate feature preferences, rate criteria of importance and as a group, discuss their reasons for specific vest preferences and suggestions for future improvements. Participants were issued the following Questionnaires:

- Features Questionnaire (for each vest)
- Feature Preference Questionnaire
- Criteria of Importance Questionnaire
- Exit Questionnaire (Without Plates)
- Exit Questionnaire (With Plates)

Following the completion of the questionnaire battery, a focus group discussion was held to determine which vest was preferred by the participants for the exit questionnaire human factors (HF) criteria. Finally suggestions on improving the recommended vest design were discussed.

2. Method

2.1. Features Questionnaire

Participants were asked to rate the functionality and durability of the individual design features incorporated in the three different vest designs.

2.2. Features Preferences

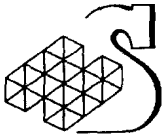
Participants were asked to rate their preference for various design features based on a bipolar scale. The preference scale was balanced with increasing preference ratings to each end of the scale from a neutral center-point. Each end of the scale comprised two different or opposite aspects of a particular vest design feature or aspect.

2.3. Criteria of Importance

Participants were asked to rate their perceived importance of various design criteria for selecting or assessing a fragmentation vest. Participants ranked each criterion using a seven-point scale of importance. These ratings were then used to produce a criterion of importance ranking.

2.4. Exit Questionnaire

Participants were issued two similar Exit Questionnaires comparing all three vest conditions against a number of HF criteria. Separate questionnaires were issued to allow for a direct vest comparison both with and without plates.



Annex L: Exit Focus Group

2.5. Exit Focus Group

During the focus group discussion participants were required to vote for the vest they most preferred for each of the human factors (HF) criteria, and then describe the reasons for their preference in a group discussion

3. Results

3.1. Features Questionnaire

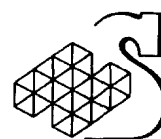
Participants were asked to rate the functionality and durability of the individual design features incorporated in the three different vest designs. Results of the participant ratings are described below for each vest.

3.1.1. Vest A

Descriptive statistics for ratings of feature durability and functionality for vest A are provided below in Tables 1 and 2.

Front Features -	Functionality		Durability	
	Mean	sd	Mean	sd
1. Collar	5.4	1.5	6.0	0.9
2. Shoulder Pad	4.8	1.4	4.8	1.7
3. Shoulder Pad Strap	4.6	1.6	4.9	1.8
4. Shoulder Pad Elastic	4.4	1.5	4.4	1.8
5. Shoulder Pad Snap	5.0	1.6	4.6	2.0
6. Shoulder Adjustment	5.6	1.6	5.6	1.0
7. Shoulder Adjustment Velcro	5.8	1.0	5.5	1.1
8. Front Plate Pocket	5.1	1.8	5.6	1.6
9. Front Plate Pocket Velcro	5.4	1.9	5.6	1.8
10. Side Adjustment	5.6	1.4	5.8	1.2
11. Side Adjustment Velcro	5.6	1.5	5.3	1.4
12. Panel Pocket Velcro	5.4	1.5	5.0	1.9
13. Shell Material	6.3	0.6	6.2	0.7

Table 1: Vest A Features (Front)



Annex L: Exit Focus Group

Back Features -	Functionality		Durability	
	Mean	sd	Mean	sd
1. Shoulder Pad Panel Pocket Velcro	5.0	1.6	5.4	1.4
2. Shoulder Pad Snap (Back)	5.0	1.6	4.6	1.8
3. Rear Plate Pocket	6.0	1.6	6.1	1.4
4. Rear Plate Pocket Velcro	6.2	1.0	6.0	1.2
5. Side Elastic Limiter Strap	6.2	1.0	5.8	1.1
6. Side Strap Pull Tab	5.9	1.4	6.0	1.0

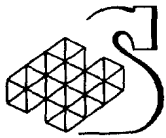
Table 2: Vest A Features (Back)

The durability and functionality of the features incorporated in Vest A were all rated as being acceptable. The durability of Vest A's elastic straps, snaps and velcro were however a concern to a number of subjects.

3.1.2. Vest B

Descriptive statistics for ratings of feature durability and functionality for Vest B are provided below in Tables 3 and 4. Features that were rated as less than acceptable are identified with shading.

Front Features	Functionality		Durability	
	Mean	sd	Mean	sd
1. Collar	2.4	1.6	4.5	1.3
2. Collar Velcro Closure	2.2	1.4	3.9	1.5
3. Shoulder Bolster	3.7	1.9	4.0	1.8
4. Shoulder Pad	3.2	1.7	4.2	1.5
5. Shoulder Pad Elastic	3.5	1.8	4.0	1.6
6. Shoulder Pad Snap (Front)	4.3	1.6	4.0	1.6
7. Single Shoulder Adjustment	3.0	1.7	4.6	1.4
8. Shoulder Adjustment Velcro	4.3	1.7	4.9	1.2
9. Shoulder Adjustment Pull Tab	4.0	2.1	4.2	1.7
10. Front Plate Pocket	5.2	1.7	5.2	1.5



Annex L: Exit Focus Group

Front Features -(Continued)	Functionality		Durability	
	Mean	sd	Mean	sd
11. Front Plate Pocket Zipper	5.7	1.6	4.4	2.0
12. Side Adjustment	3.4	1.6	4.7	1.3
13. Side Adjustment Velcro	3.7	1.8	4.6	1.6
14. Side Adjustment Pull Tab	4.1	2.3	4.8	1.8
15. Panel Pocket Zipper	5.4	1.2	4.9	1.4
16. Waist Belt	3.1	2.1	3.8	1.7
17. Shell Material	5.5	1.5	5.4	1.4

Table 3: Vest B Features (Front)

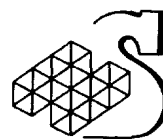
Back Features	Functionality		Durability	
	Mean	sd	Mean	sd
1. Collar Panel Zipper	3.3	1.7	3.8	1.8
2. Shoulder Pad Panel Pocket Zipper	3.8	1.8	4.3	1.6
3. Shoulder Pad Snap (Rear)	3.8	1.7	4.0	1.5
4. Rear Plate Pocket	5.9	1.1	5.8	1.1
5. Rear Plate Pocket Velcro	6.0	1.0	5.8	1.3

Table 4: Vest B Features (Back)

The participants rated the majority of Vest B's features as being unacceptable for functionality or durability. The collar design of Vest B was rated as being *Barely to Reasonably Unacceptable* for functionality. The shoulder pad, single shoulder adjustment, side adjustment and waist belt design features were all rated as being unacceptable (*Borderline to Barely Unacceptable*). Subjects did rate the ballistic plate pockets as being *Reasonably Acceptable* for functionality and durability.

3.1.3. Vest C

Descriptive statistics for ratings of feature durability and functionality for Vest C are provided below in Tables 5 and 6.



**Annex L:
Exit Focus Group**

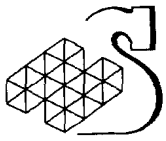
Front Features	Functionality		Durability	
	Mean	sd	Mean	sd
1. Collar	4.8	1.8	5.8	1.0
2. Collar Snap	4.6	2.1	4.7	1.7
3. Collar Velcro	4.8	1.9	4.0	1.9
4. Shoulder Pad Strap	5.5	1.8	5.5	1.5
5. Shoulder Pad Limiter Strap	5.4	1.8	5.1	1.8
6. Shoulder Pad Adjustment Velcro	5.6	1.5	4.8	1.9
7. Shoulder Pad Velcro Locking Strap	5.7	1.6	5.2	2.0
8. Front Plate Pocket	4.6	2.2	5.5	1.4
9. Side Adjustment Strap	5.6	1.3	5.7	1.3
10. Side Adjustment Velcro	5.6	1.7	5.1	1.8
11. Side Strap Pull Tab	5.8	1.1	5.9	1.0
12. Panel Pocket Velcro	5.4	1.9	5.2	1.8
13. Shell Material	4.8	1.9	5.4	1.1

Table 5: Vest C Features (Front)

Back Features	Functionality		Durability	
	Mean	sd	Mean	sd
1. Collar	4.9	2.0	5.5	1.5
2. Collar Snaps (Rear)	5.2	1.9	5.0	1.7
3. Rear Plate Pocket	5.5	1.9	6.0	1.1
4. Rear Plate Pocket Velcro	6.2	0.9	6.0	1.0

Table 6: Vest C Features (Back)

The durability and functionality of the features incorporated in Vest C were all rated as being acceptable. The durability of Vest C's elastic straps, snaps and velcro were however, a concern to a number of subjects



Annex L: Exit Focus Group

3.2. Features Preferences

Participants were asked to rate their preference for various design features based on a bipolar scale. The preference scale was balanced with increasing preference ratings to each end of the scale from a neutral center-point. Each end of the scale comprised two different or opposite aspects of a particular vest design feature or aspect.

Summary descriptive statistics (mean, standard deviation) are depicted in Figure 1 below.

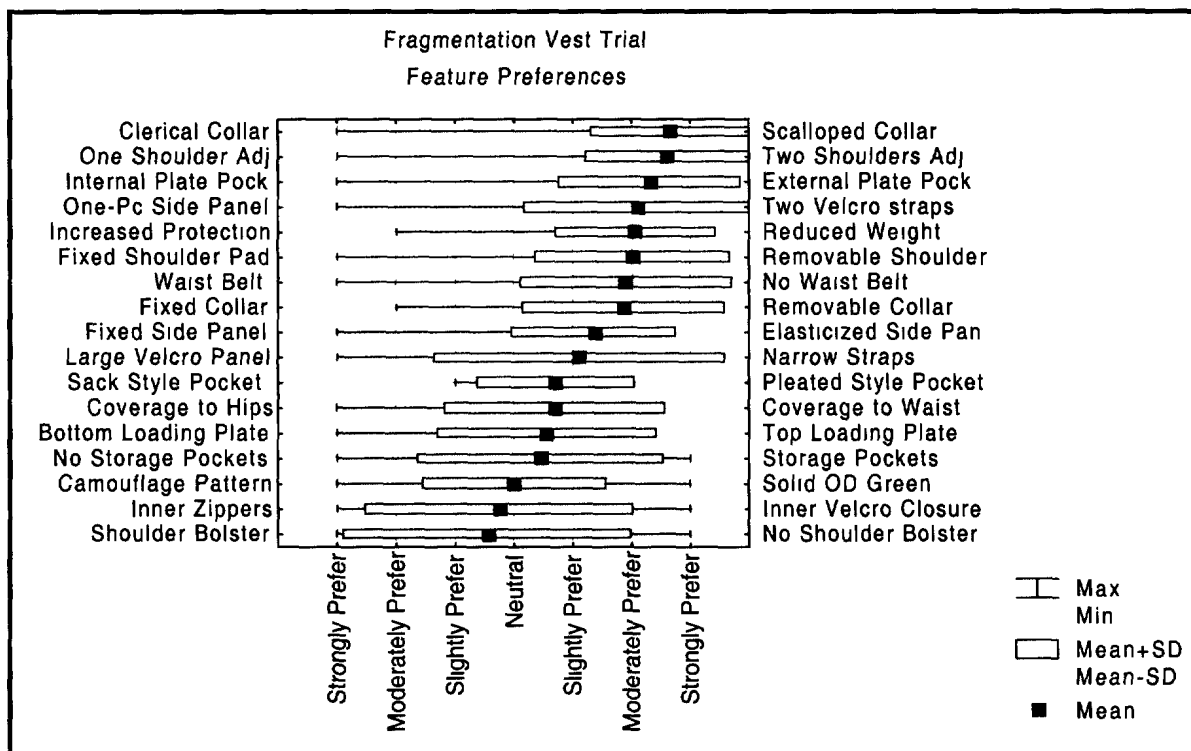
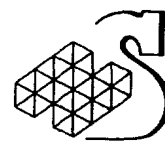


Figure 1: Feature Preferences

3.2.1. General Design Considerations

Participants evidenced a moderate to strong preference for reducing vest weight versus adding increased protection. Participants evidenced a moderate to strong preference for the removable shoulder pads available with Vest A versus the fixed shoulder pad of Vest B. There was just a slight preference for coverage to the waist rather than coverage to the hips. Participants expressed a moderate to strong preference for no waist belt. There was no substantial preference between a camouflage-coloured shell or a solid OD Green shell.



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- **Increased Protection vs. Decreased Weight:** 100% of participants believed that the level of protection in Vest A was sufficient. For a certain level of protection, participants would rather use materials that would retain the level of protection but would reduce overall weight, rather than have additional protection for the same amount of weight. The participants believed that reducing the bulk and mobility restrictions of vests is more important than gaining additional protection.
- **Coverage to the Waist vs. Coverage to the Hips:** Participants preferred coverage to the waist versus coverage to the hips because it offered greater task compatibility. The added length of Vest B caused compatibility problems with vehicle operation and prone weapon firing.
- **Waist Belt vs. No Waist belt:** All but one participant felt the waist belt of Vest B was not functional. Participants typically did not secure the belt but left it hanging down inside the vest.

3.2.2. Shoulder Design Characteristics

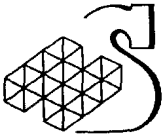
Participants evidenced a moderate to strong preference for two shoulder fit adjustments available with Vests A and C versus the single shoulder adjustment design of Vest B. Participants evidenced a moderate to strong preference for the removable shoulder pads available with Vest A versus the fixed shoulder pads of Vest B. There was just a slight preference for a shoulder bolster.

- **Two Shoulder Adjustment vs. One Shoulder Adjustment:** 100% of participants believed that dual adjustable shoulder straps provided better fit and adjustability. Commentary indicated that the shoulder velcro retention straps should be similar in design to Vest A. Participants did not favour the narrow straps of Vest C or the extremely large panel of Vest B.
- **Removable Shoulder Pad vs. Fixed Pad:** Participants preferred the removable shoulder pad because it offered greater task compatibility. Removing the shoulder pads allow the crews of vehicles greater mobility and ease of ingress and egress. Removing shoulder pads can increase the ease of mobility while doing FIBUA operations. Conversely, users can add the pads when the situation dictates. None of the participants expressed any concern over losing a shoulder pad.

3.2.3. Collar Design Characteristics

Participants evidenced a moderate to strong preference for a scalloped collar available with Vests A and C versus the high-sided clerical collar design of Vest B. Participants evidenced a moderate to strong preference for the removable collar available with Vest C versus the fixed collars of Vests A and B.

- **Scalloped Collar vs. Clerical Collar:** 100% of participants believed that clerical collar of Vest B was uncomfortable. The high collar caused chaffing.
- **Removable Collar vs. Fixed Collar:** Participants preferred the removable collar because it offered greater task compatibility. Removing the collar and shoulder pads allows participants the ability to wear their vests underneath their outer jackets, reducing bulk and mobility restriction. None of the participants expressed any concern over losing a collar.



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3.2.4. Side-Adjustment Design Characteristics

Participants evidenced a moderate to strong preference for the two straps side adjustment system available with Vests A and C versus the single piece adjustment design of Vest B. Participants evidenced a slight to moderate preference for elasticized side straps available in Vests A and C versus the non-elasticized side adjustment available with Vest B.

- **Two-Straps vs. One-Piece Side Adjustment:** A majority of participants believed that the two strap system of Vests A and C offered more adjustability than the single side adjustment of Vest B. The dual strap system allowed the participants to achieve a better fit at the waist and chest region. The dual strap system also allowed more adjustment than the single side when worn over top of combat jackets and parkas..
- **Elasticized Side Straps vs. Non-elasticized Side Straps:** Participants did not prefer the non-elasticized side straps of Vest B because the side attachment Velcro frequently opened inadvertently when the wearer bent over at the waist. The elasticized straps of Vest A and C stretched and thus did not rip apart when pulled taught. Additionally the elasticized straps of Vest A and C allowed for easier donning and doffing. Vest B wearers typically required help to don.

3.2.5. Plate Pocket Design Characteristics

Participants evidenced a moderate to strong preference external plate pockets available in Vests A and C (back plate only) and Vest B (front and back plate). Participants evidenced a slight preference for top loading plates, pleated style pockets and preferred the use of Velcro over zippers for pocket closures.

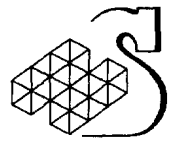
- **External Plate Pocket vs. Internal Plate Pocket** A Participants preferred the ability to add both the front and back plates on to Vest B without resorting to opening the inner carrier shell (Vests A and C). If the situation dictates wearers can mount the plates with assistance by a helper without removing their fragmentation protection.

3.3. Criteria of Importance

A Criteria of Importance questionnaire was administered at the end of testing during the Exit Focus Group. Participants rated the perceived importance of various design criteria for selecting or assessing a fragmentation vest. Participants ranked each criterion using a seven-point scale of importance. These ratings were then used to produce a criterion of importance ranking. Summary descriptive results (mean, standard deviation) are depicted in Figure 2. Criteria have been arranged in order of strongest to weakest importance.

The criteria of importance results are based upon the results of this trial and the knowledge base the participants brought to the trial. Since the weather was quite cool, thermal problems were not important; if the trial was conducted during the heat of summer, thermal comfort may have been extremely important. Similarly, if one design had been significantly different than the other designs i.e. Gen "O", the Ease of Movement may have been the most important criteria. While the general results of the criteria of importance can be applied to other vests, the specific results for this criteria of importance ranking is context and trial specific.

The criteria of importance results were subsequently analyzed by K-means Cluster Analysis (n=5) to organize the results into distinct groups. K-means Cluster Analysis is currently being utilized by the



Annex L: Exit Focus Group

CTS project for bid evaluation purposes. The results of the K-means Cluster analysis is depicted in Figure 3:

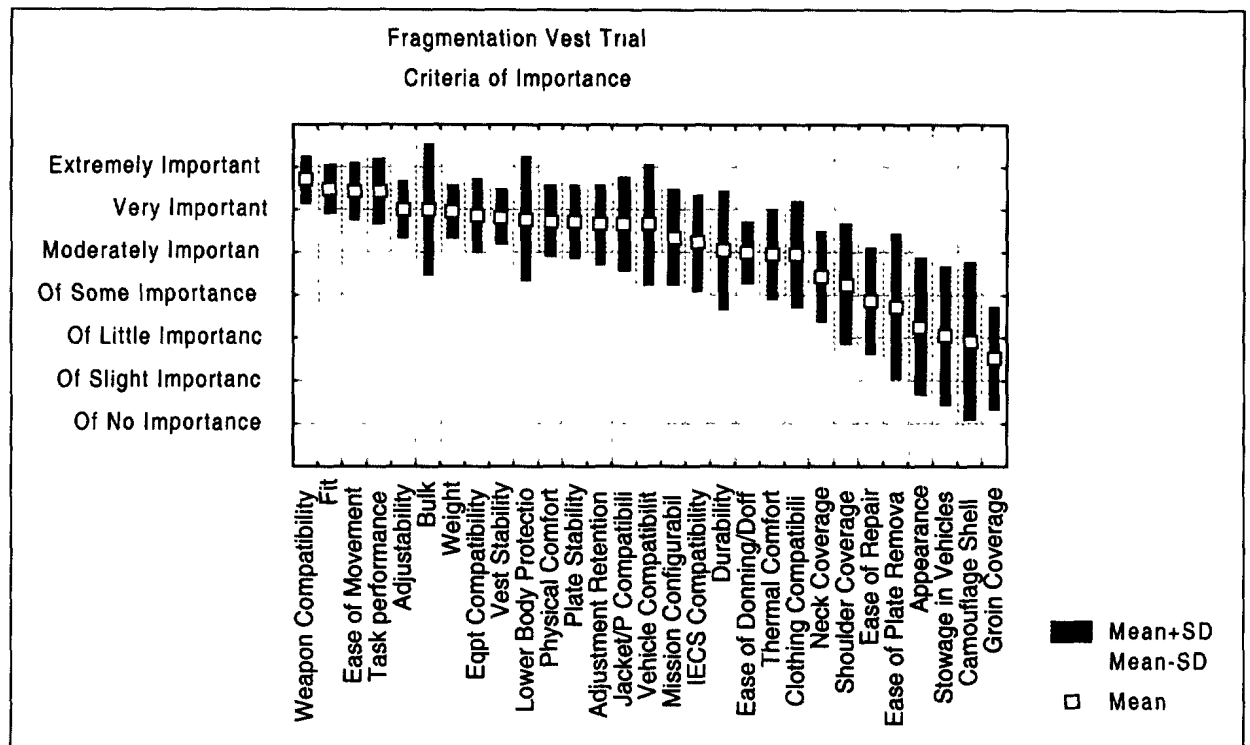
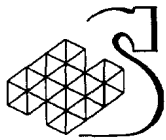


Figure 2: Criteria of Importance Questionnaire Results



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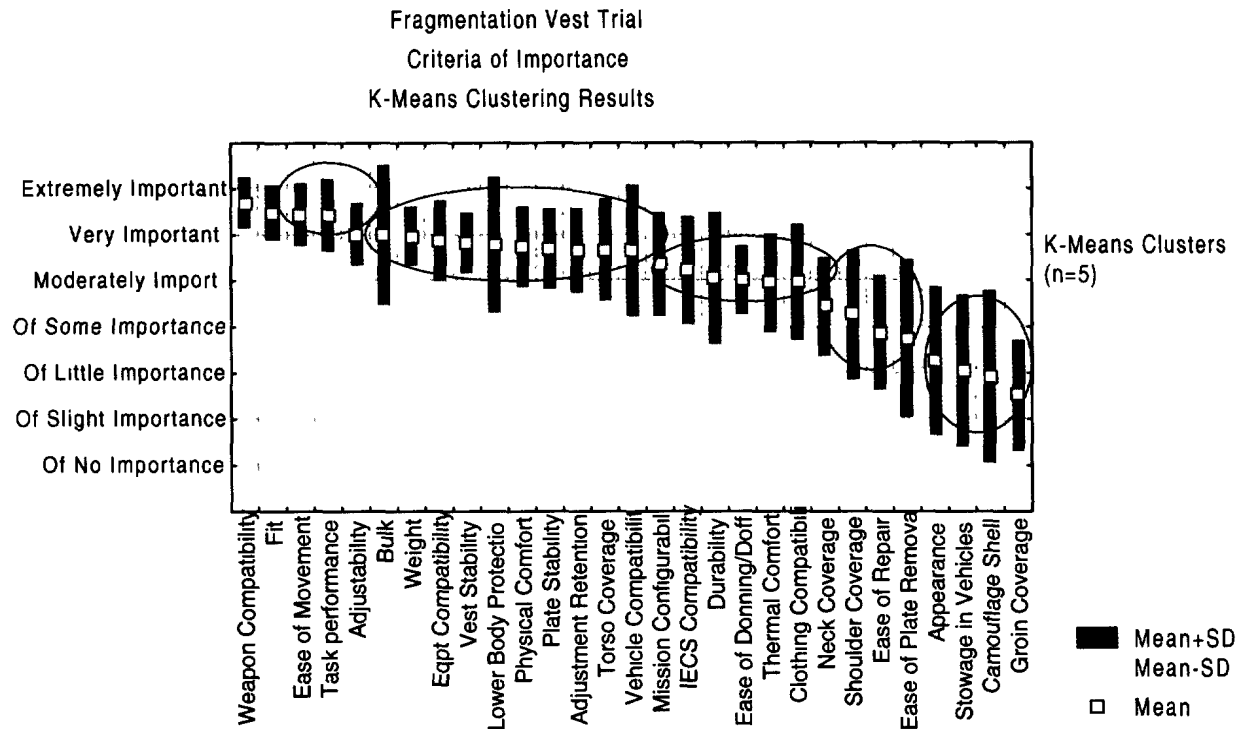


Figure 3: K-Means Cluster Analysis Results

3.3.1. Very Important to Extremely Important

Participants rated four criteria in the highest importance category: Weapon Compatibility, Fit, Ease of Movement, and Task Performance.

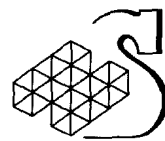
Focus group discussions confirmed that a number of the criteria above were the most important features to consider for the selection of a fragmentation vest. Participants indicated that fragmentation vests must fit (to minimize instability), must be compatible with weapons and must not hamper task performance.

3.3.2. Very Important

Participants rated 11 criteria in this category: Adjustability, Bulk, Weight, Equipment Compatibility, Vest Stability, Lower Body Protection, Physical Comfort, Plate Stability, Adjustment Retention, Torso Coverage, and Vehicle Compatibility.

3.3.3. Moderately Important

Participants rated six criteria in this category: Mission Configurability, Durability, Ease of Donning and Doffing, Thermal Comfort, IECS Compatibility and Clothing Compatibility.



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3.3.4. Slightly Important

Participants rated four criteria in this category: Neck Coverage, Shoulder Coverage, Ease of Repair and Ease of Plate Removal.

3.3.5. Least Important

Participants rated four criteria in this category: Appearance, Stowage in Vehicles, Camouflage Shell and Groin Coverage.

3.4. Exit Questionnaire

Participants were issued two similar Exit Questionnaires comparing all three vest conditions against a number of HF criteria. Separate questionnaires were issued to allow for a direct vest comparison both with and without plates.

3.4.1. Exit Questionnaire without Plates

Overall, Vest A was rated significantly more acceptable than Vests C and B (*Reasonably Acceptable*) –see Figure 4. Vest C was also rated significantly more acceptable than Vest B overall (*Borderline to Barely Acceptable*). Overall, Vest B was rated as being unacceptable (*Reasonably Unacceptable*). Results for each vest condition are described below.

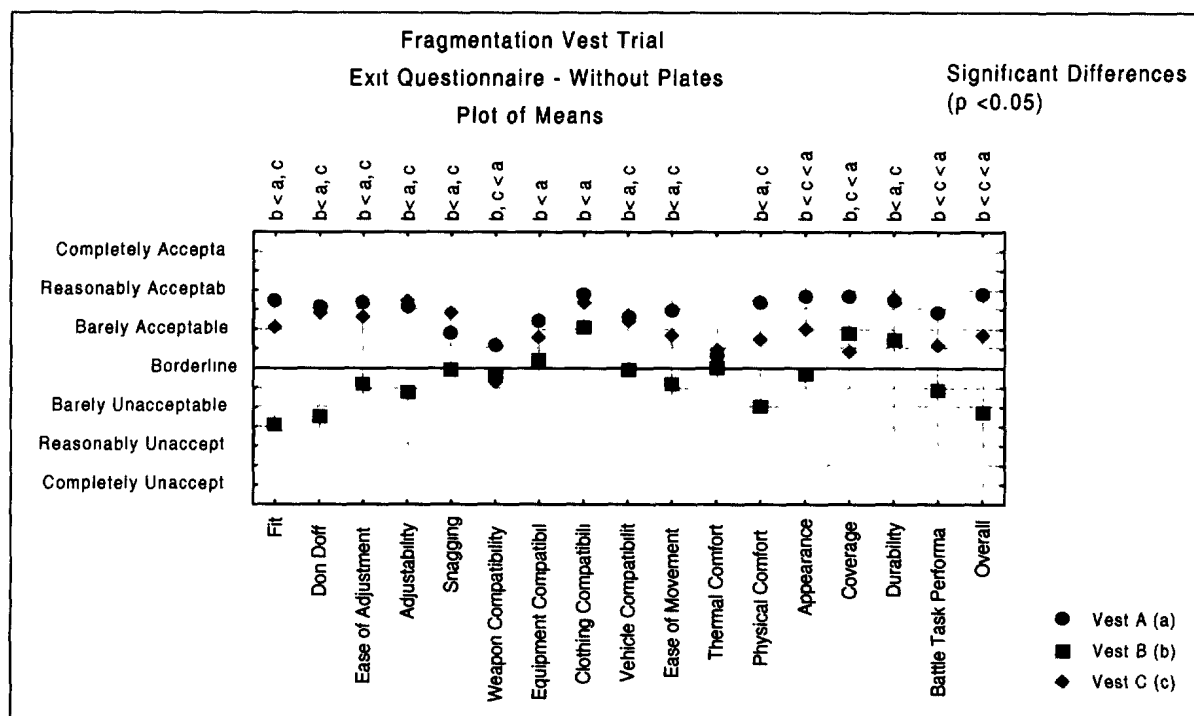
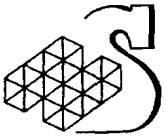


Figure 4: Exit Questionnaire (Without Plates) Results



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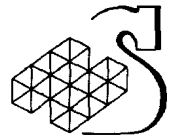
Vest A: Vest A received an average rating of *Barely to Reasonably Acceptable* across all the Exit Questionnaire criteria. Except for Thermal Comfort, Vest A was rated significantly ($p<0.05$) more acceptable than Vest B for all exit questionnaire rating criteria. Vest A was also rated significantly more acceptable than Vest C for all exit criteria less Snagging, Equipment and Clothing Compatibility, Thermal Comfort and Durability.

Vest B: Vest B received an average rating of *Borderline to Barely Unacceptable* across all the Exit Questionnaire criteria. Except for Thermal Comfort, Vest B was rated significantly ($p<0.05$) less acceptable than Vest A for all exit questionnaire rating criteria. Vest B was also rated significantly ($p<0.05$) less acceptable than Vest C for all exit criteria less Weapon, Equipment and Clothing Compatibility, Thermal Comfort, and Coverage.

Vest C: Vest C received an average rating of *Borderline to Barely Acceptable* across all the Exit Questionnaire criteria. Vest C was rated significantly ($p<0.05$) less acceptable than Vest A for Weapon Compatibility, Appearance, Coverage, and in Battle Task Performance. Vest C was also rated significantly ($p<0.05$) more acceptable than Vest B for all exit criteria less Weapon, Equipment and Clothing Compatibility, Thermal Comfort, and Coverage.

3.4.2. Exit Questionnaire with Plates

Overall, Vest A was rated significantly more acceptable than Vests B and C (*Reasonably Acceptable*) – see Figure 5. Vest C was also rated significantly ($p<0.05$) more acceptable than Vest B overall (*Borderline to Barely Acceptable*). Overall, Vest B was rated as being unacceptable (*Reasonably Unacceptable*). Results for each vest condition are described below.



Annex L: Exit Focus Group

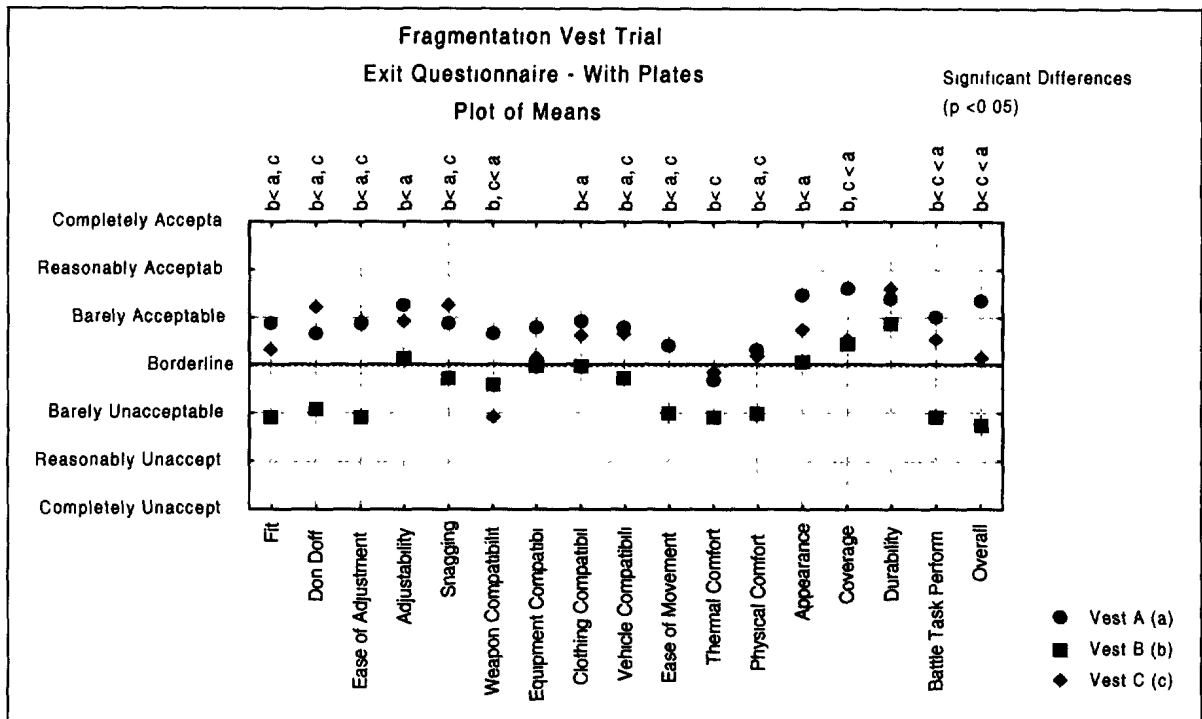
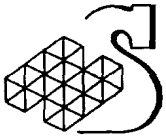


Figure 5: Exit Questionnaire (With Plates) Results

Vest A: Vest A received an average rating of *Borderline to Barely Acceptable* across all the Exit Questionnaire criteria. Except for Equipment Compatibility, Thermal Comfort and Durability, Vest A was rated significantly ($p < 0.05$) more acceptable than Vest B for all exit questionnaire rating criteria. Vest A was also rated significantly more acceptable than Vest C for Weapon Compatibility and Battle Task performance.

Vest B: Vest B received an average rating of *Borderline to Barely Unacceptable* across all the Exit Questionnaire criteria. Except for Equipment Compatibility, Thermal Comfort and Durability. Vest B was rated significantly ($p < 0.05$) less acceptable than Vest A for all exit questionnaire criteria. Vest B was also rated significantly less acceptable than Vest C for all exit criteria less Adjustability, Weapon, Equipment and Clothing Compatibility, Thermal Comfort, Appearance, Durability and Coverage.

Vest C: Vest C received an average rating of *Borderline to Barely Acceptable* across all the Exit Questionnaire criteria. Vest C was rated significantly ($p < 0.05$) less acceptable than Vest A for Weapon Compatibility, Appearance, Coverage, and in Battle Task Performance. Vest C was also rated significantly ($p < 0.05$) more acceptable than Vest B for all exit criteria less Adjustability, Equipment and Clothing Compatibility, Appearance, Durability and Coverage.



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3.5. Exit Focus Group

During the focus group discussion participants were required to vote for the fragmentation vest they most preferred for each of the human factors (HF) criteria, and then describe the reasons for their preference in a group discussion.

Participants indicated a strong and consistent preference for Vest A over Vests B and C for most HF criteria. Conversely, participants indicated a strong and consistent dislike of Vest B in most HF criteria. Overall, 17 of the 23 participants indicated that Vest A was the best fragmentation vest evaluated, while six subjects indicated that Vest C was the best vest evaluated. None of the participants felt that Vest B was acceptable for operational fielding.

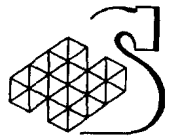
Participants felt that Vest A was the best compromise between coverage and manoeuvrability. While Vest B had more coverage, its bulk and limits on freedom of movement compromised battle task performance. Conversely Vest C had the greatest freedom of movement, but it offered the least coverage. Participants believed Vest B had too much coverage, while Vest C had too little coverage. All participants indicated that if given a choice, they would sacrifice the extra coverage provided by Vest B to achieve the agility and ease of movement provided in Vest A. Participants were particularly vocal in their dislike of the extra protection by Vest B's neck design. While the clerical collar neck provides more protection it was uncomfortable and irritating. Similarly, participants found that the extra shoulder pad coverage provided by Vest B compromised ease of movement, weapon compatibility and battle task performance as well, they promoted snagging problems.

All participants believed that they achieved the best fit with Vests A(21/23) and C (2/23). The elastic side straps and adjustable shoulder straps provided them with a measure of fit and adjustability not achievable with Vest B. The majority of participants believed Vest B was too long (12/23) and its neck was too tight (18/23). A number of subjects (7/23) felt that Vest C's fit was too tight across the chest and five females felt their breasts were being squished.

Unlike Vests A and C, Vest B required the use of a partner to properly adjust and don. Every subject (23/23) reported having more difficulty donning and doffing Vest B. Participants particularly had problems adjusting the non-elasticized side panels (18/23) of Vest B. Participants also reported adjustment retention difficulties with Vest B; if the participant bent over or twisted the Velcro side panel would rip apart. Only one subject thought the internal belt was a good feature, while 22 of 23 participants did not think it functioned acceptably.

A majority of subjects experienced snagging problems with Vest B (18/23). Snagging problems were particularly noticeable during the vehicle compatibility stands, during the FIBUA battle tasks and when donning the tactical assault vests. Vest A also experienced snagging difficulties with its shoulder pads (11/16) when donning the tactical assault vests. Vest A's shoulder pad frequently bunched and flipped over during TAV donning procedures.

The majority of participants (21/23) believed that Vest A was the most compatible with weapon firing. The bulk of Vest B, its stiff neck design, longer torso length and large



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shoulder pads caused problems for the majority of participants (18/23). The narrow shoulder strap design of Vest C also caused weapon compatibility problems with a majority of subjects (16/23). Subjects could not properly shoulder their rifles in the prone position with Vest C. Participants also reported similar problems with the other vests.

All of the subjects utilizing the 82-pattern webbing as their load carriage system (8/8) reported equipment compatibility problems with the vests. Yoke straps frequently slid off the shoulders of the vests that they were wearing. Additionally, the 82-pattern users believed that there was a design problem at the shoulder – typically the webbing strap was resting half on the fragmentation shoulder strap and half off.

A majority of subjects believed that Vest B had clothing compatibility problems (14/23). While Vests A and C could be used with combat jackets without difficulty and with parkas if necessary, participants did not believe that Vest B was suitably compatible with any jacket or parka due to neck and bulk problems.

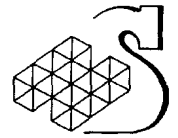
The majority of participants believed that Vest C provided the best ease of movement (14/23), while 7/23 participants believed Vest A provided the best ease of movement. Conversely, nearly all subjects (22/23) believed that Vest B provided the worst ease of movement.

While all of the subjects believed that any fragmentation vest would be thermally demanding, they believed the side attachment designs of Vests A and C allowed them to vent easier. Loosening off the side straps allowed natural billowing and forced air movement under the vest. Vest B's design limited the ability of participants to ventilate.

The majority of participants believed that Vest A allowed for the best battle task performance (13/23), while 10/23 participants believed Vest C provided the best battle task performance.

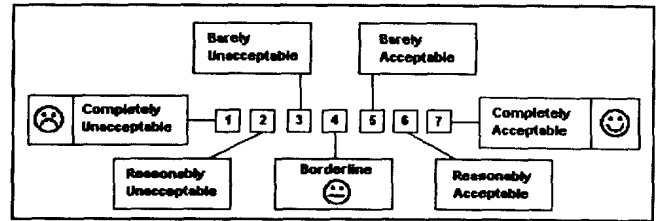
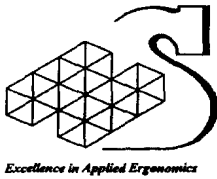
4. Discussion

Following an extensive series of tests over five days and having worn all three vest conditions in each test, the 23 participants had a strong preference for Vest A versus Vests B or C. Vest B was consistently rated less favourably than Vests A and C. While Vest B possessed more protection, the added coverage compromised weapon, clothing and equipment compatibility, task performance, comfort, range of motion and mobility.



**Appendix 1 to Annex L:
Exit Focus Group**

**APPENDIX 1 TO ANNEX L:
Features Questionnaires**

**PERSONAL DATA**

Clearly print your Name and Subject Number in the boxes provided.

NAME

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SUBJECT NUMBER

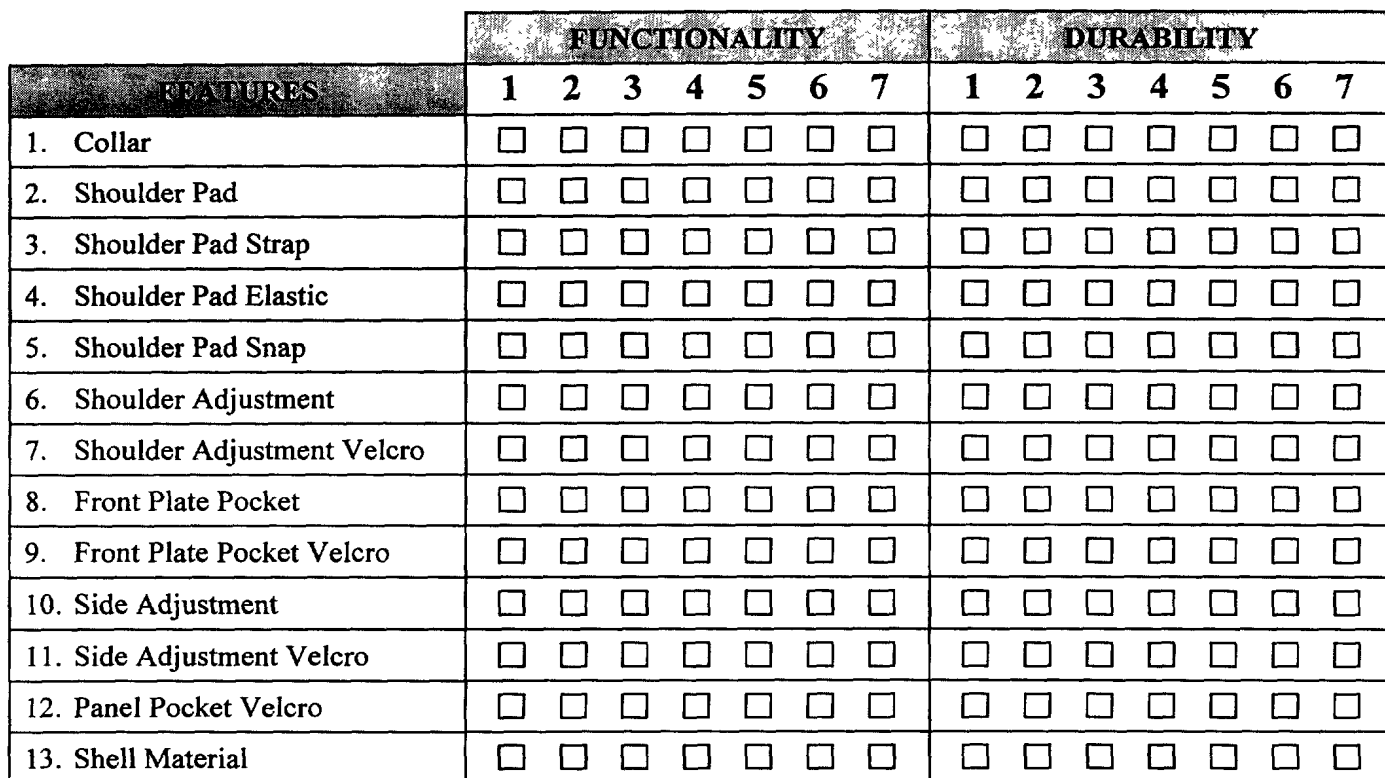
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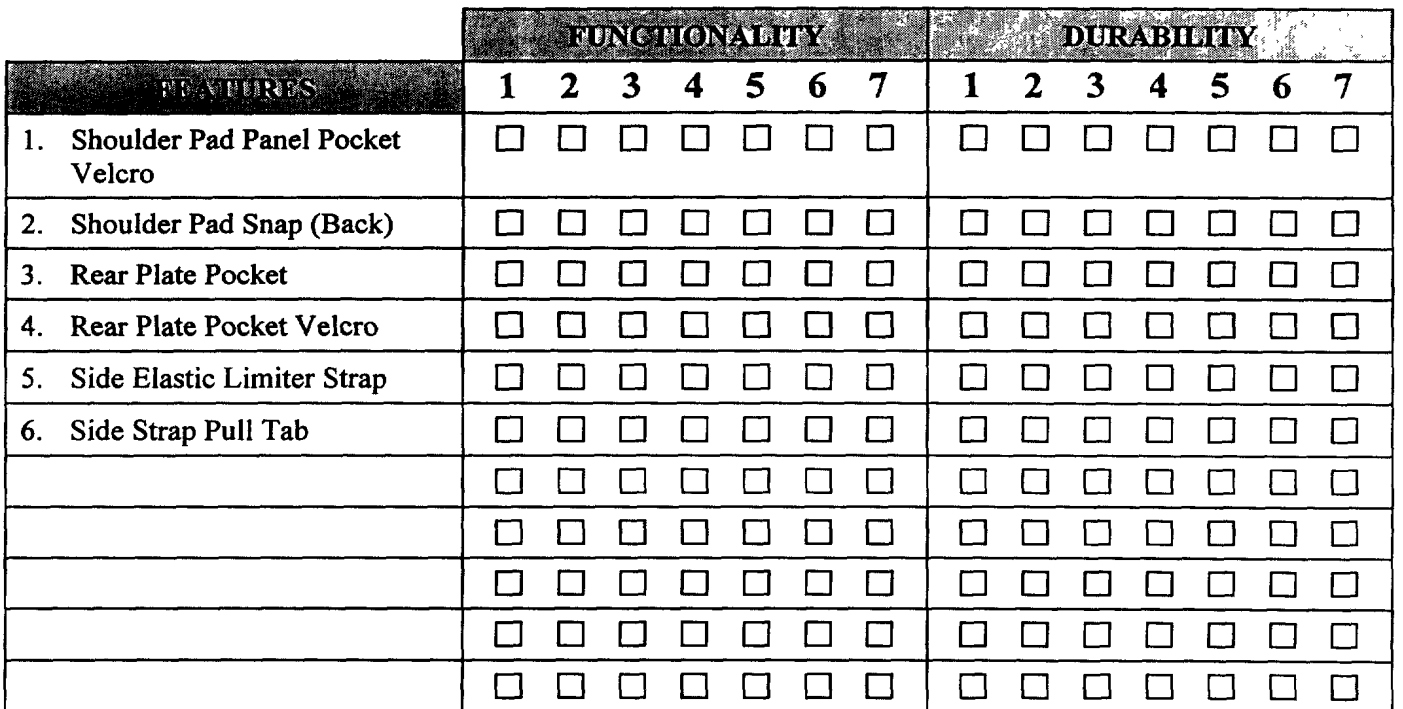
LOAD CARRIAGE TYPE: 82 Pattern Webbing: ☐ TAV: ☐**DIAGRAMS**

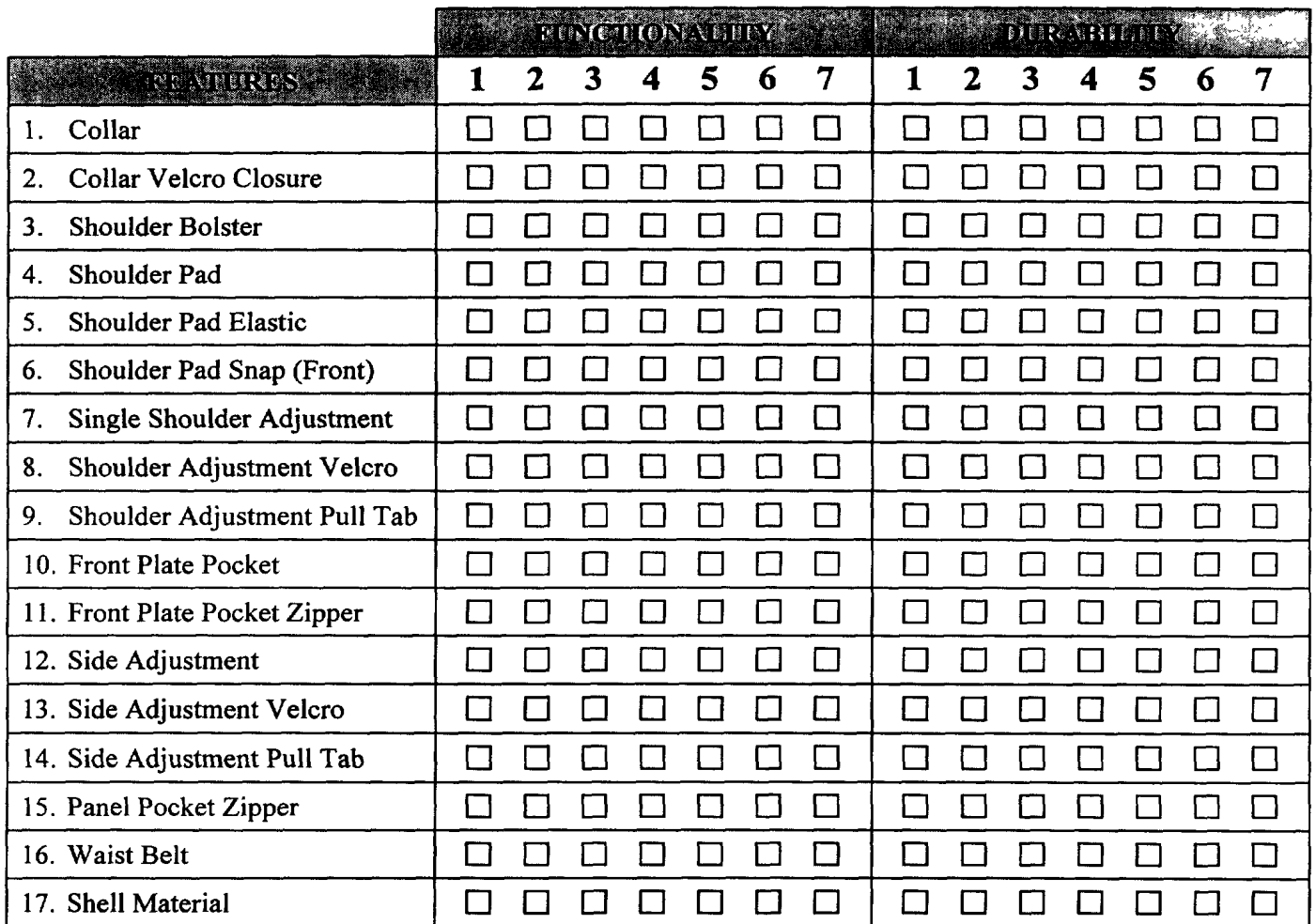
Diagrams of the Vest A System are attached. Critical features have been labelled on the diagrams and tabulated below. Provide a rating of acceptability, using the 7-point scale above, for functionality (ie. how well the feature works) and durability (ie. will the feature last?). Provide additional comments in the box provided below.

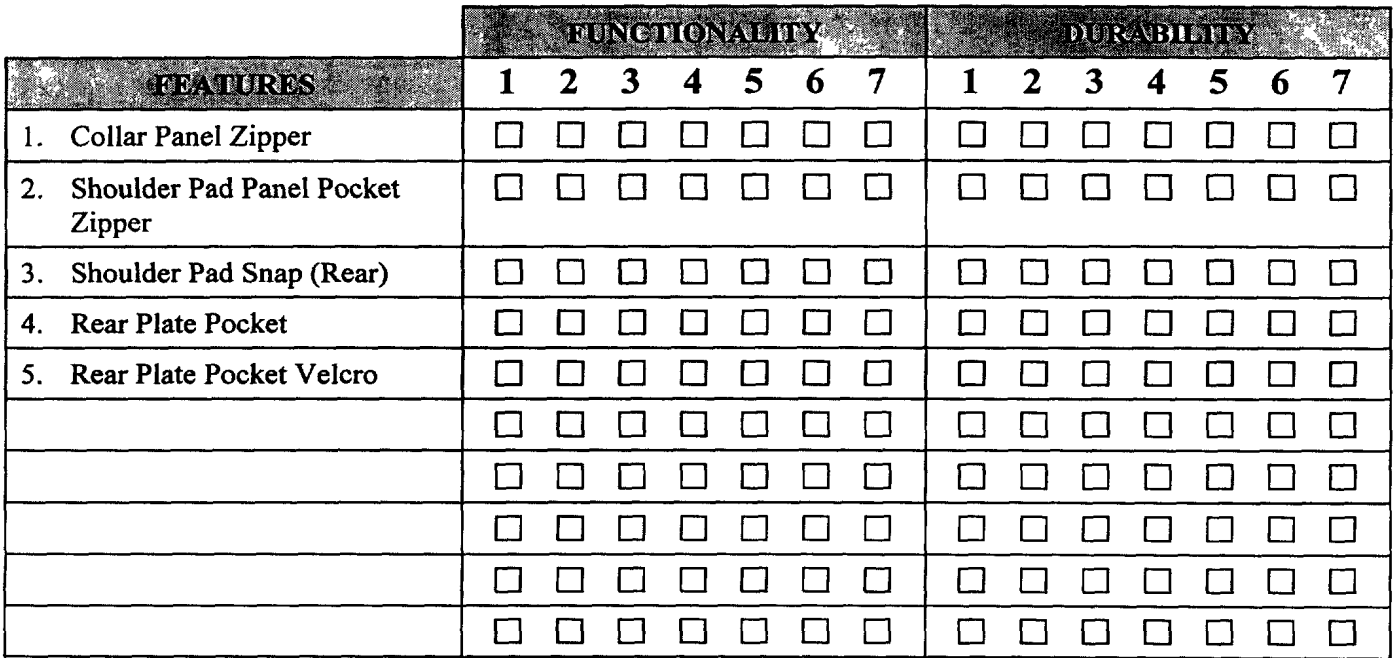
COMMENTS

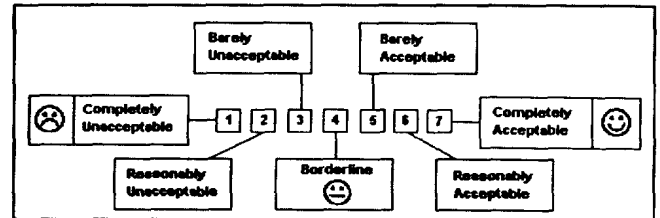
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Clearly print your Name and Subject Number in the boxes provided.

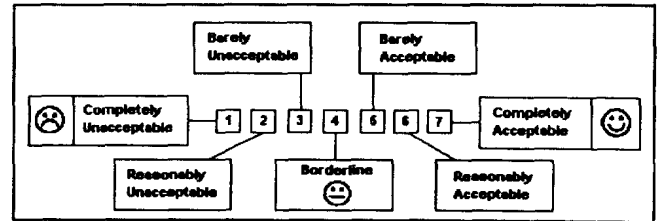
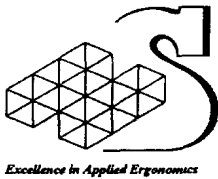
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DIRECTOR'S MESSAGE

ONLINE

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**PERSONAL DATA**

Clearly print your Name and Subject Number in the boxes provided.

NAME

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SUBJECT NUMBER

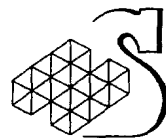
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LOAD CARRIAGE TYPE: 82 Pattern Webbing: ☐ TAV: ☐**DIRECTIONS**

Diagrams of the Vest B System are attached. Critical features have been labelled on the diagrams and tabulated below. Provide a rating of acceptability, using the 7-point scale above, for functionality (ie. how well the feature works) and durability (ie. will the feature last?). Provide additional comments in the box provided below.

COMMENTS

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**Appendix 2 to Annex L:
Exit Focus Group**

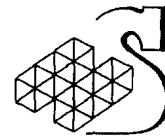
**APPENDIX 2 TO ANNEX L:
Features Preference Questionnaire**



Fragmentation Vest – Feature Preferences

	Feature Preferences							
	Strongly Pref	Mod Pref	Slightly Pref	Neutral	Slightly Pref	Mod Pref	Strongly Pref	
One Shoulder Adjustable	☐	☐	☐	☐	☐	☐	☐	Two Shoulders Adjustable
Large Velcro Shoulder Attachment Panel	☐	☐	☐	☐	☐	☐	☐	Narrow Shoulder Straps with Locking Flap
Fixed Shoulder Pads	☐	☐	☐	☐	☐	☐	☐	Removable Shoulders Pads
Shoulder Bolster	☐	☐	☐	☐	☐	☐	☐	No Bolster
Fixed Collar	☐	☐	☐	☐	☐	☐	☐	Removable Collar
Clerical Collar (same collar height around the neck)	☐	☐	☐	☐	☐	☐	☐	Scalloped Collar (collar cut out at front of the neck)
Waist belt	☐	☐	☐	☐	☐	☐	☐	No Waist Belt
Large One-Piece Velcro Side Attachment Panel	☐	☐	☐	☐	☐	☐	☐	Two Separate Velcro Side Adjustment Straps
Elasticized Side Panel	☐	☐	☐	☐	☐	☐	☐	Unstretchable Side Panel Straps
Inner Panel Zipper Closures	☐	☐	☐	☐	☐	☐	☐	Inner Panel Velcro Closures
Coverage to Waist	☐	☐	☐	☐	☐	☐	☐	Coverage to Hip
1000 D Shell Material	☐	☐	☐	☐	☐	☐	☐	500D Shell Material
Camouflage Pattern	☐	☐	☐	☐	☐	☐	☐	Solid OG Green
Storage Pockets	☐	☐	☐	☐	☐	☐	☐	No Storage Pockets
Increased Protection for Same Weight	☐	☐	☐	☐	☐	☐	☐	Same Protection but Reduced Weight
Internal Plate Pockets	☐	☐	☐	☐	☐	☐	☐	External Plate Pockets
Top Loading Plate Pockets	☐	☐	☐	☐	☐	☐	☐	Bottom Loading Plate Pockets
"Pleated" Style Plate Pocket	☐	☐	☐	☐	☐	☐	☐	"Sack" Style Plate Pocket
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	

Comments:



**Appendix 3 to Annex L:
Exit Focus Group**

**APPENDIX 3 TO ANNEX L:
Criteria of Importance Questionnaire**

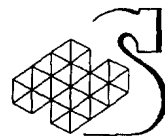


Fragmentation Vest – Criteria Importance



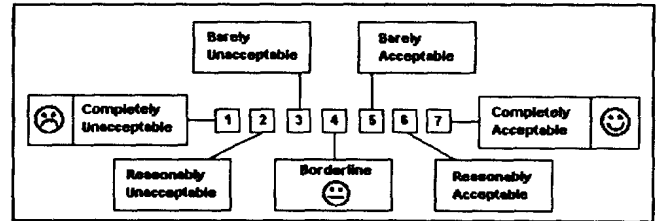
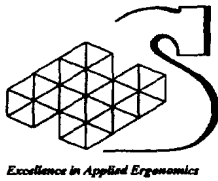
	Criteria Importance						
	Of No Importance	Of Slight Importance	Of Little Importance	Of Some Importance	Moderately Important	Very Important	Extremely Important
Fit	☐	☐	☐	☐	☐	☐	☐
Adjustability	☐	☐	☐	☐	☐	☐	☐
Vest Stability	☐	☐	☐	☐	☐	☐	☐
Bulk	☐	☐	☐	☐	☐	☐	☐
Adjustment Retention	☐	☐	☐	☐	☐	☐	☐
Camouflage Shell	☐	☐	☐	☐	☐	☐	☐
Ease of Movement	☐	☐	☐	☐	☐	☐	☐
Physical Comfort	☐	☐	☐	☐	☐	☐	☐
Thermal Comfort	☐	☐	☐	☐	☐	☐	☐
Stowage in Vehicles	☐	☐	☐	☐	☐	☐	☐
Appearance	☐	☐	☐	☐	☐	☐	☐
Compatibility w vehicles - hatches, driving, etc.	☐	☐	☐	☐	☐	☐	☐
Compatibility w Jackets or Parkas	☐	☐	☐	☐	☐	☐	☐
Compatibility w Other Clothing Items	☐	☐	☐	☐	☐	☐	☐
Weapon Compatibility	☐	☐	☐	☐	☐	☐	☐
Equipment Compatibility	☐	☐	☐	☐	☐	☐	☐
Durability	☐	☐	☐	☐	☐	☐	☐
Mission Configurability	☐	☐	☐	☐	☐	☐	☐
Ease of donning/doffing	☐	☐	☐	☐	☐	☐	☐
Ease of Repair	☐	☐	☐	☐	☐	☐	☐
Weight	☐	☐	☐	☐	☐	☐	☐
Ease of Panel Replacement	☐	☐	☐	☐	☐	☐	☐
Plate Stability	☐	☐	☐	☐	☐	☐	☐
Level of Ballistic Protection	☐	☐	☐	☐	☐	☐	☐
Shoulder Coverage	☐	☐	☐	☐	☐	☐	☐
Torso Coverage	☐	☐	☐	☐	☐	☐	☐
Neck Coverage	☐	☐	☐	☐	☐	☐	☐
Groin Coverage	☐	☐	☐	☐	☐	☐	☐
Task Performance	☐	☐	☐	☐	☐	☐	☐

Use back of page to make any comments.



**Appendix 4 to Annex L:
Exit Focus Group**

**APPENDIX 4 TO ANNEX L:
Exit Questionnaire (Without Plates)**

**PERSONAL DATA**

Clearly print your Name and Subject Number in the boxes provided.

NAME

--	--	--	--	--	--	--	--	--	--	--	--	--

SUBJECT NUMBER

--	--

LOAD CARRIAGE TYPE: 82 Pattern Webbing: ☐ TAV: ☐

Rate the following features:		User Acceptance Rating							Comments
		1	2	3	4	5	6	7	
FIT	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
DONNING/ DOFFING	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
EASE OF ADJUSTMENT	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
ADJUSTMENT RETENTION	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	



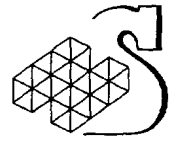
Rate the following Features		User Acceptance Rating							Comments
		1	2	3	4	5	6	7	
SNAGGING	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
WEAPON COMPATIBILITY	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
EQUIPMENT COMPATIBILITY	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
CLOTHING COMPATIBILITY	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
VEHICLE COMPATIBILITY	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
EASE OF MOVEMENT	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
THERMAL COMFORT	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	



Rate the following Features		User Acceptance Rating							Comments
		②		②		③			
		1	2	3	4	5	6	7	
PHYSICAL COMFORT	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
APPEARANCE	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
COVERAGE	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
DURABILITY	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
BATTLE TASK PERFORMANCE	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	
OVERALL RATING	Vest A:	☐	☐	☐	☐	☐	☐	☐	
	Vest B:	☐	☐	☐	☐	☐	☐	☐	
	Vest C:	☐	☐	☐	☐	☐	☐	☐	

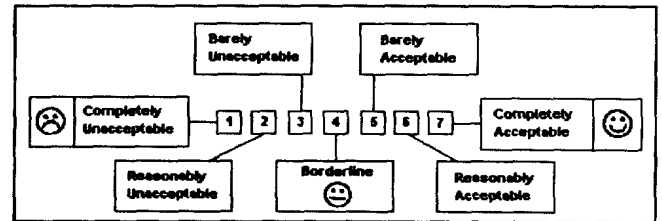
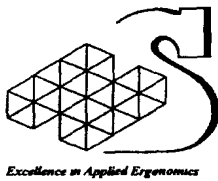


COMMENTS:



**Appendix 5 to Annex L:
Exit Focus Group**

**APPENDIX 5 TO ANNEX L:
Exit Questionnaire (With Plates)**



PERSONAL DATA		Clearly print your Name and Subject Number in the boxes provided.							
NAME									
SUBJECT NUMBER									
LOAD CARRIAGE TYPE:		82 Pattern Webbing: ☐ TAV: ☐							
Please Rate the Following:		User Acceptance Rating							Comments
		1	2	3	4	5	6	7	
FIT	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
DONNING/ DOFFING	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
EASE OF ADJUST -MENT	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
ADJUST -MENT RETENTION	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	



Rate the following Features	User Acceptance Rating							Comments
	⊕ 1	2	3	⊖ 4	5	6	⊙ 7	
SNAGGING Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
WEAPON COMPAT-IBILITY Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
EQUIPMENT COMPAT-IBILITY Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
CLOTHING COMPAT-IBILITY Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
VEHICLE COMPAT-IBILITY Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
EASE OF MOVEMENT Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
THERMAL COMFORT Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	



Rate the following Features		User Acceptance Rating							Comments
		☹			☺			☺	
		1	2	3	4	5	6	7	
PHYSICAL	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
COMFORT	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
APPEARANCE	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
COVERAGE	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
DURABILITY	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
BATTLE TASK	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
PERFORMANCE	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	
OVERALL	Vest A with plates:	☐	☐	☐	☐	☐	☐	☐	
RATING	Vest B with plates:	☐	☐	☐	☐	☐	☐	☐	
	Vest C with plates:	☐	☐	☐	☐	☐	☐	☐	



COMMENTS:

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14 ABSTRACT

(U) 'In 1991, the Canadian Forces (CF) designed and built a fragmentation vest for the protection of our Land Force personnel against ballistic threats during military operations. Operational deficiencies with the fragmentation vest were reported shortly after introduction into service; these deficiencies included excessive stiffness, degraded mobility, and incompatibility with helmets, weapon sights and in-service personal load carriage equipment. In order to resolve the in-service vest deficiencies, a series of human factors (HF) investigations were undertaken as part of the G2122 Fragmentation Vest Modification programme. Based on the recommendations from these trials, NDHQ selected a side-opening vest design as most suitable to pursue for the CF Fragmentation Vest Modification Programme (Generation II design). The aim of this programme was to salvage the ballistic fill of the deficient fragmentation vests and incorporate it into a better design.

The G2122 programme was subsequently cancelled and a decision was made to not salvage the soft armour from existing in-service stocks, but rather to transfer funds and authority to procure a new fragmentation vest as part of the Cloth the Soldier (CTS) Project. The CTS project staff decided to develop two fragmentation vest prototypes incorporating the advantages afforded by new ballistic materials. One design was based upon the latest modification of

the earlier Generation II design, and the other upon the "Danish" fragmentation vest design

The primary aim of this field trial is to evaluate the human factors (HF) suitability of two new prototype fragmentation vest designs, by comparison with the original Generation II design

A five-day field trial was undertaken at CFB Petawawa over the period 28 September to 02 October 1998. Three fragmentation vest systems were evaluated by a total of 24 regular force male (

15 KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) Generation III Fragmentation Vest, Fragmentation Vest, Ballistic Vest, Ballistic Protection, Cloth the Soldier, Human Factors Evaluation, Danish Fragmentation Vest, Generation II Fragmentation Vest, Field Trial

515033